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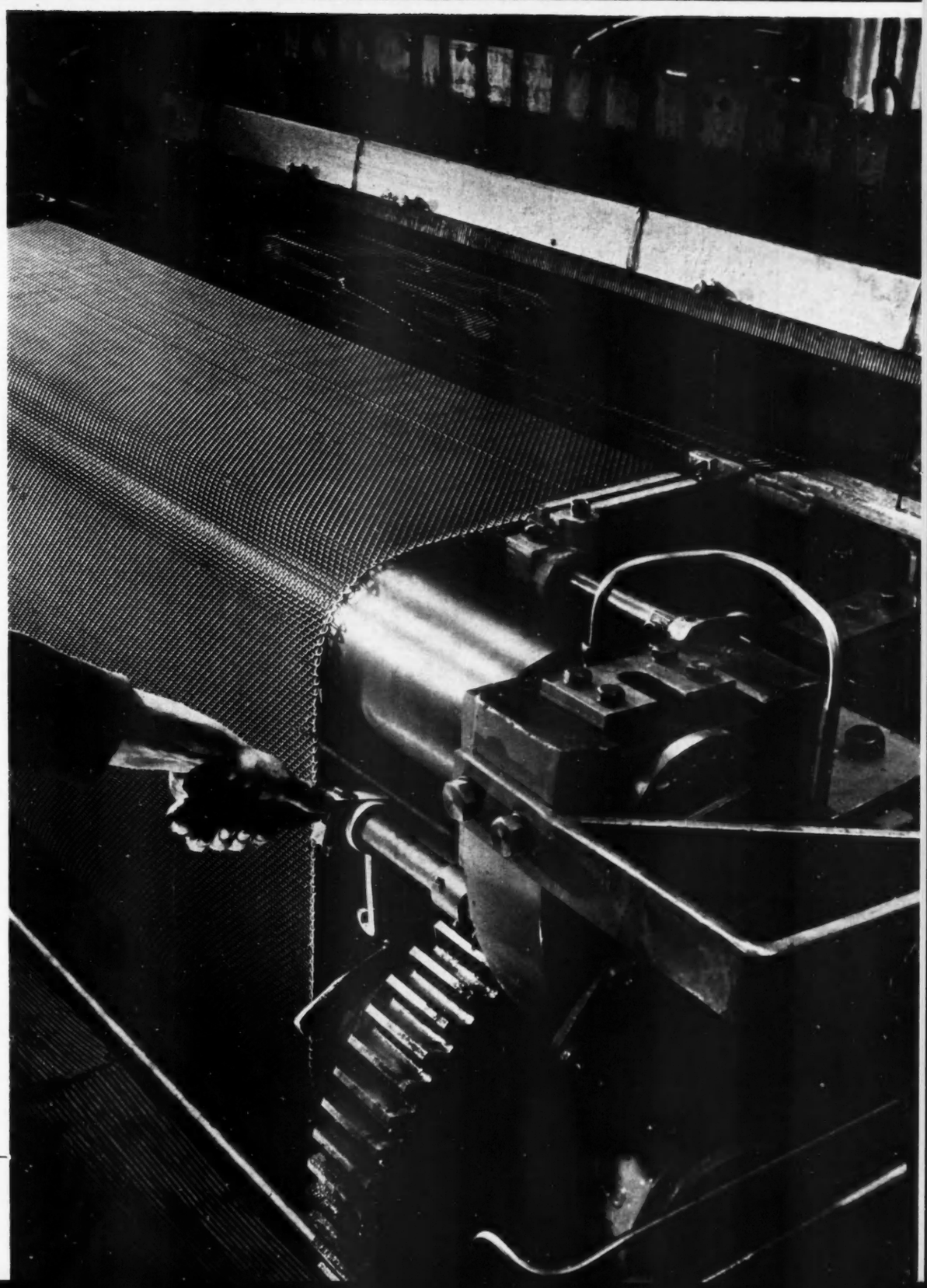

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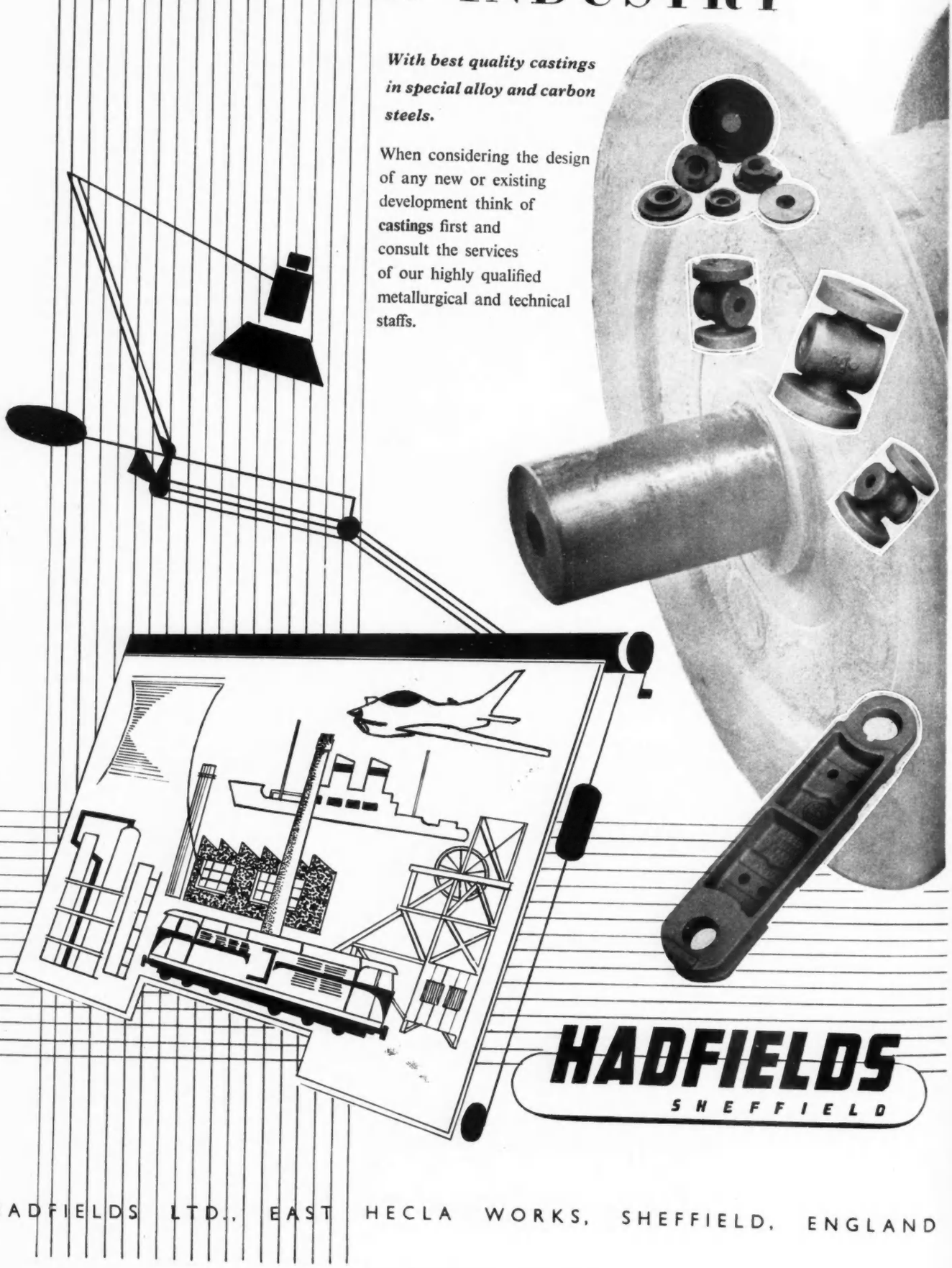

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Contents

597 **Leading Article**
Holding Hands is Not Enough
598 **Plain Words**
598 **Weekly Survey**
599 **Letters to the Editor**
Structures to Withstand Earthquakes
602 **Special Article**
Hanover Fair: Market Place for European Industry
604 **Companies in the News**
606 **Atomic Review**
Thermonuclear Engineering
609 **In Parliament**
612 **Automobile Engineering**
The Ten-Plus Brake Meter: Changes in Motion Registered on Multipurpose Dial
Farina-bodied Riley
616 **Meetings and Papers**
617 **On the Shelf**
617 **Publications**
Sampled-Data Control Systems
Hydraulic Turbines: Their Design and Equipment
Optimale Stufenrädergetriebe für Werkzeugmaschinen
New Books
Trade Publications
628 **At Home**
Which Refrigerator?
Roll-up Ladder

. . . . . .

600 **New Plant and Equipment**
Crack Detector, Borer, Cable Tracer, Strip Cutter, Can for Liquids, Jig Borer, Deep Draw Press, Boiler Dampers, Packaged Cooling Tower, Bulk Elevator
605 **The Human Element**
610 **Construction**
Carried on Air
One Acre of Plywood and Aluminium Sail
Closing Flood Gates in an Emergency
613 **Research and Development**
Twenty-one Years of Coal Research: BCURA Comes of Age
Measuring Gear Teeth Errors under Load
Space Probes and Satellites: A Summary of Progress
619 **Metals and Materials**
Marine Boiler Refractories: Constructional Materials for Known Service Conditions
Compressed Air Extinguishes Oil Fires
Sintered Tungsten Shanks
Fibre Filter Exploits Hydrophobia
Aromatic Extraction Unit
621 **Design**
Drum Suction Strainer
Improved Passenger Vehicles
Swivel Pipe Couplings
Steam Valve with Streamline Flow
Fire Float for Fiji
Triangular Spindles from Flats
Fixed Bobbin Stranding Machine
Fail-Safe Tests on Boeing
Roller Brackets for Temporary Support Girders
Good Design Means Mass Acceptance
Centralised Signalling at Newcastle Central
625 **Production**
Batch Production of High Speed Hydraulic Pumps
Melting in a Vacuum: Alloy Steels with Minimum Contamination
627 **Marketing**

ENGINEERING *Appointments Section faces page 612*

Holding Hands is Not Enough

A SLIM yellow volume published recently by the OEEC is in some ways one of the most significant documents to be put out by a European organisation for some time. It is called quite modestly *The Work of the Organisation for European Economic Cooperation* (7*s*) and has the subtitle "A Report by the Secretary General." Now why should what appears to be a routine report have any special significance? There are several reasons for picking out this particular report from the general run. For one thing, it is the first of its kind. It is not the OEEC annual report, but an account of the year's work by the Organisation's chief executive, M. René Sergent, who clearly feels that there is urgent need to put the record of OEEC before the public. In particular, he shows that cooperation in secondary projects was not sufficient to create the great cooperative climate which many had seen as the solution to Europe's problems.

The story he has to tell is most impressive, except for one thing—the major setback to the progress of OEEC represented by the failure of the negotiations for the Free Trade Area at the end of last year. Otherwise OEEC has carried out a great variety of useful tasks extremely well. It is interesting to recall that OEEC was one of the bodies that provided financial help to France at the beginning of last year. Without this aid the liberalisation of trade and the revaluation of the currency last December would not have been possible.

But apart from stepping in with aid in times of emergency, OEEC has a number of agencies, standing committees and working parties of various degrees of importance on all the major problems facing national governments today. The European Nuclear Energy Agency which is jointly responsible for the Winfrith Heath high temperature gas-cooled reactor is an outstanding example of cooperation of this sort. Another is the Office of Scientific and Technical Personnel which the OEEC has organised as a means of helping member governments improve the existing facilities for training teachers of science and technology. Other OEEC committees deal with the different fuels, and there is an energy advisory commission which will be reporting later this year on the future needs of each source of energy, including nuclear power. All these long-term planning activities of OEEC are in addition to what may be called its routine tasks. These include discussions at ministerial level of national economic policies, the running of the European Monetary Agreement, reviews of the effects of national agricultural policies, and assistance for less developed countries.

The story of what OEEC has done is very impressive. But it is a story with the moral that cooperation, like patriotism, is not enough. The failure of OEEC to reach agreement with the Six over the Free Trade Area marks the end of its influence in Western Europe. In the course of his report M. René Sergent lists six matters on which the members of the Maudling Committee reached, or could have reached, agreement. It is worth noting that the full name of this committee was the Intergovernmental Committee set up by the Council of OEEC. The points on which agreement was possible were: (*a*) rules for abolishing customs tariffs and quantitative restrictions on imports and exports; (*b*) rules of competition (aids to exports), subsidies and restrictive commercial practices); (*c*) the right to set up new factories in other member countries; (*d*) the free movement of services and capital; (*e*) international transport policies; and (*f*) the coordination of economic policies and methods of dealing with balance of payments problems and payments agreements.

All these were matters on which the Six and the other OEEC countries, including Britain, were ready to agree. Any government prepared to accept outside rulings on these problems is clearly prepared to go a very long way towards integration of its economic policies with those of other member governments. But not all the way. Three vital problems remained, on which agreement was not anywhere in sight. These were: (*a*) the problems arising from not having a common external tariff; (*b*) problems concerning the harmonisation of laws covering social policies; and (*c*) the whole question of international institutions and voting rules.

The failure to come to agreement on these particular problems emphasises the fundamental difference of view between Britain and the Six, especially the French and the Germans, on what cooperation is all about. The points of difference on the Free Trade Area were political not economic. As long ago as February, 1957, an OEEC working party examined the problem and reported that a Free Trade Area associated with the Common Market of the Six was a feasible proposition. But on the political front the objective of the Six was the unification of Europe. Any arrangement which weakened this unity, and the Free Trade Area was seen in this light, was far from "feasible," no matter how many concessions were made on minor points.

Cover Picture.—*Weaving wire mesh. The loom will handle plain or twill weave, ranging from 2 mesh by 16 s.w.g. to 40 mesh by 34, s.w.g., 5 ft wide, in all metals for industrial screening and grading of aggregates and fine powders.*

(*Nurnberg photograph for* ENGINEERING)

Plain Words

At the summer exhibition of the Royal Academy there is a portrait of Sir William Stanier, F.R.S., by William Dring, R.A. Below his name on the frame are the words "President, Institution of Mechanical Engineers, 1941," but the picture was painted quite recently. The same artist also exhibits a portrait of Professor A. J. S. Pippard, F.R.S., this year's President of the Institution of Civil Engineers. There are a few—very few—pictures of industrial scenes, but I wouldn't hold that against the artists; landscapes and birds and nudes are much more interesting and presumably sell better.

In the architectural room there are some fine drawings and models, which have the additional merit that they are easy to view as there are never the crowds in that room that there are in the main galleries. You can stand and examine at leisure the designs for a new reading room at Harwell Atomic Energy Research Establishment, for research laboratories of the Mullard Radio Valve Company, for Stafford College of Technology, for a factory of the Cement Marketing Company, and for a laboratory of the Shell Refinery Company. All these designs have been submitted by the architects. There is nothing odd about that, but I was a little puzzled when I found that there are also designs for such basically engineering projects as bridges, a transonic wind tunnel, and—it is hardly credible—the vertical tandem generator at Harwell. On some of the bridge designs the name of the consulting engineers is also given—Rendel, Palmer and Tritton for example—but clearly it is the architect who is supposed to have the aesthetic sense.

Now you may say that that is as it should be; that architects can be left to get on with the job of making things look pretty and engineers can be left to make them work. Or that engineering is not an art but a science. All right, let's accept that for the moment while we step out of the Royal Academy of Arts and take a few strides across the forecourt of Burlington House to the Royal Society (which, incidentally, is much the older of the two bodies). Surely, if engineers don't bother very much with the Academy they must be busy giving papers to the Royal Society. No, Sir! Very few papers are from engineers.

Well, which is engineering—an art or a science? And is a man-made thing less beautiful the more functional it is? That is a heresy which engineers should wipe out. In 1837, I. K. Brunel exhibited at the Royal Academy—"Brent Viaduct, at Hanwell, being part of the G.W.R."

CAPRICORN

Weekly Survey

Space Fiction or Fact?

There has been a Government undertaking for some time to make a firm statement on space satellite research. Last week the question was raised in the House of Commons, but the statement was not to be made until this week. These matters have been considered in the light of American and Soviet programmes and the considerable contribution that Britain has already made in interpreting the information provided by other people's satellites (see ENGINEERING, 2 April, p. 440). The achievements in space research to date of Britain, the US and USSR are summarised in an article on page 615.

A Labour member asked what plans there were for using the Blue Streak and Black Knight missiles during test firings in Australia as vehicles for launching missiles into space. He asked the Government to set up a committee of scientists and engineers directly responsible to the Ministry of Supply for carrying out such a project. He suggested that there should be a modest project costing between £10 million, and £20 million, spread over the next 5 years, to make satellites of about 1 ton acting as space laboratories for about 10 years. The Parliamentary Secretary to the Ministry of Supply would say no more than that the Government were giving active consideration to an earth satellite programme, that they had taken into account the possibility of using the two missiles in Australia for carrying satellites into space, and that a further statement would be made. The Labour member appears to have been quite well informed. On the same day one of the peers moved for papers on the Air Estimates and the question of space research was again raised. One speaker said that he thought this country should go into space research as a matter of priority. In his opinion the United Kingdom had already lost scientists and engineers to America because there was no space research programme in this country.

It is no easy decision to make. However modest the initial outlay may be, space research by this country will involve in the end a very heavy commitment of resources unless it is to die off early because the attempt has only been half hearted.

State of Fusion

The excitement early last year over what some thought to be the imminent development of thermonuclear reactors, by which power might be produced from sea water, was later considerably damped by the discovery of new and formidable difficulties. These problems are already better understood. In opening the recent Convention on Thermonuclear Processes organised on behalf of the British Nuclear Energy Conference by the Institution of Electrical Engineers, Dr. B. F. J. Schonland, director of the Atomic Energy Research Establishment, Harwell, outlined the present state of this research.

The main effort at present, he said, was directed towards the making and containment of plasma under laboratory conditions, and the study of whether the ions could be given a random distribution of velocities, since these nuclei would only undergo fusion with a net yield of energy if these motions were in all directions. What had to be demonstrated in the last stage of this work was that enough of this energy in a controllable—though not necessarily continuous—form could be extracted from a device which would supply power economically, taking full account of the cost of the fuel, of the equipment itself and the power needed to operate it.

It became clear in the course of the year 1958, and crystal clear after the Geneva Conference, that in spite of much brilliant theoretical, experimental and engineering work, no one in the world had yet succeeded with certainty in the very first stage of producing a true controlled thermonuclear reaction. The emission of neutrons from these devices has been in most cases only an index of plasma instability. The confinement of plasma for a time long enough to heat it to the necessary temperature had turned out to be exceedingly difficult. In all devices so far carried to what should be the point of "ignition" most of the energy put in to heat the plasma was lost from it extremely rapidly and only a small fraction was retained as heat. It appeared that intense ultraviolet radiation from impurity ions was one source of loss. There was evidence of another loss mechanism in intense X-rays, mainly soft X-rays, produced at the walls by runaway electrons able to escape from magnetic restraint as a result of local perturbations of the plasma itself. There was also the possibility of intense high frequency or microwave radiation from the plasma. The vehicles of energy loss and their relative importance were likely to be clear before very long and attention was already being concentrated on the mechanisms of instability which give rise to them.

High temperature conducting plasmas were subject both to large-scale and to small-scale instabilities. The former which were hydromagnetic had been expected and ingeniously countered in devices such as Zeta and the Stellarator. But the small-scale instabilities needed much more study before they could be controlled for they seemed to arise from extremely complex turbulence in the current-carrying skin of the plasma. Whether this perturbation was due to subtle hydromagnetic disturbances, to the excitation of electrostatic plasma vibrations or to unstable oscillations in plasma magnetic fields was not known. Until the problem was resolved, the achievement of stage one would resemble Mrs. Beaton's misquoted recipe for jugged hare—"First catch your hare"—for it was an elusive one.

These experiments required energy storage arrangements of a novel kind, high-current switchgear of a speed and nature never before contemplated, and electronic and diagnostic devices of an unusual character. In this country attention was at present directed mainly towards intensive study of plasmas produced in the pinch device, slow and fast, and towards novel forms of pinch containment. Thought was also being given to other means of containment such as mirror machines. The general policy of the United Kingdom Atomic Energy Authority was to experiment, with the object of understanding the plasma and the forces which mould it. Until this work was completed it was idle to talk of a thermonuclear reactor. But it might well turn out that the suppression of instabilities, fine grained and large, was a matter of a few simple tricks. The business of the applied scientist and the engineer was to tame nature; it had been done before and would be done again.

Film Festival

Schlieren, made by the Shell Film Unit, was awarded the British Association's Diploma of Merit. This British film which was shown at the Harrogate Festival of Films in the Service of Industry was selected as being the best exposition of the scientific principles underlying an industrial process. "Schlieren" means internal streaks, and a system of photography was developed in German in the 19th century to use the refraction of light to reveal faults in glass. With the advent of colour photography this system has now

important uses in aerodynamic research. Shell showed this to effect in their first two films on high-speed flight and *Schlieren* was made to explain to a wide public the photographic system. It includes not only examples of the technique used in aerodynamic research, but also includes many homely instances—air rising from the human hand or from an ice-cream; air circulating from a wall radiator; clear liquids mixing; shock waves generated by a sparking plug; even the air rising from the air holes of a recorder on which is being played "pop goes the weasel."

This was one of 113 British and 23 foreign films shown during the festival. Many were concerned with engineering. British transport enjoyed the distinction of having fourteen films accepted for display, with at least one in each of the nine competitive categories. They ranged from *Under Night Streets*, an account of night maintenance on the London Underground, to *Between the Tides* (an account of marine life on the Pembrokeshire coast—a film which won the other British Association Diploma as the film best presenting science to the public). *Groundwork for Progress* recounted some of the civil engineering work in progress in connection with railway modernisation; *Rail Stress* was a popular study of research into stresses imposed on the leading edges of rails, especially around the fishbolt holes, occasioned by the impact of rolling-stock wheels (stresses increased by the multiple-small wheel bogies of electric and diesel locomotives). *Diesel Train Driver* surely roused the boyhood yearnings of every male in the audience.

While few engineering organisations produce and use films on the scale of British Transport, many make enterprising use of the medium. John Laing's simple but exciting account of progress in the construction of the southern section of the London-Yorkshire Motorway. *Adma for short* made by World Wide for BP related the story of the construction of a floating oil drilling rig which could be elevated on to hydraulic stilts to bore (successfully in the event) for oil beneath the waters of the Persian Gulf. *Metals of the Nuclear Age* showed some of the fascinating metallurgical developments in nuclear engineering whilst *Steam and Steam Generation*, in discussing the properties and industrial applications of steam, showed that a force which contributed must to the first industrial revolution still has a lot to give to the second.

Musical Chairways

The latest round of squabbles over who should land their aircraft where, approaches *opera bouffe*, if not *symphonie fantastique*. Not even the latter is characterised by the discords which seem periodically to shatter the apparently harmonious *bonhomie* of certain members of IATA (not to mention the Civil Aeronautics Board). The first sufferer of 1959 was KLM, when their plans to land airliners at Singapore were frustrated by BOAC. Then BOAC, pursuing an ambitious scheme to circle the globe by jet propulsion, were themselves checked by strong protests from Northwest Airlines. The United States operator's reasoning was simple. BOAC would not let them land at Hong Kong, thus depriving them of a useful source of revenue, therefore why let BOAC take away an estimated £1·78 million worth of business by using Tokyo as a staging post for their round-the-world tour? (Pan American meanwhile kept discreetly in the background; they already have rights to land at Hong Kong.)

While Northwest Airlines and BOAC were arguing their case before the Civil Aeronautics Board, Mr. H. A. Slotemaker, executive vice-president of KLM was counselling the International Chamber of Commerce in Washington on the advantages of greater freedom. This in itself savoured of the ironic in the light of the failure of KLM, to come to terms on a quota agreement with competitive European airlines. Nevertheless, Mr. Slotemaker was certainly correct when he said that protectionism was of constant concern to those involved in air transport. His colleague, Mr. Wassenburgh, deputy head of KLM's foreign relations department, revealed the hub of the problem as the excess capacity arising from the advent of jet aircraft.

Few would disagree with this thesis, although a major airline might justifiably reply that it it would be inequitable if they incurred a considerable amount of expenditure on developing new routes, only to find their competitors reaping the benefits. Without some modicum of agreement—and therefore of control—undue multiplication of services might result, and many airlines would find themselves incurring high running costs with an uneconomic payload factor. BOAC, with its current estimated deficit of £4¾ million, could least of all afford such consequences.

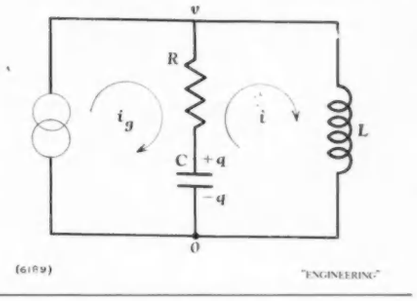
What They Said About the Budget

British industry had few regrets about Mr. Amory's second Budget. Mr. William F. McFadzean, president of the Federation of British Industries, has expressed himself well satisfied with the reliefs distributed by the Chancellor. Addressing the annual meeting of the FBI's western region at Cardiff on 27 April, Mr. McFadzean welcomed a Budget which was closely in line with the Federation's recommendations. The Budget, in short, set out to promote investment, cut costs, and reduce taxes, with a view to encouraging a steady expansion of the economy.

With these aims the FBI was in complete agreement. The eulogies expressed by some branches of industry were not however altogether endorsed by Mr. McFadzean. Some of the minor tax reforms suggested by the Federation were not adopted, while he also felt that the Chancellor had perhaps not gone far enough in such items as investment allowances. Some branches of industry also feel that much more could have been taken off purchase tax on some items, notably those companies producing radio and other domestic electronic equipment, most of which, with the welcome exception of cathode ray tubes, still bears a burden of 50 per cent. The Society of Motor Manufacturers and Traders would also have liked to see further reductions in purchase tax on cars, although they were naturally well pleased with the removal of this imposition on commercial vehicle chassis. No Budget has ever pleased everybody, but British industry has few causes for complaint here.

To judge from the tenor of Mr. McFadzean's address, indeed, the economic outlook is very satisfactory. The overgrowth of inflation had been cut back, and everything was now ready for healthy expansion. The trade unions are not, however, in anything like such a complacent frame of mind. The day after Mr. McFadzean's speech, the national committee of the AEU was in a militant mood. At their meeting, any hopes that further wage claims might be sacrified for the sake of more leisure were finally scotched, when the delegates rejected their leaders' advice and put forward demands for both.

STRUCTURES TO WITHSTAND EARTHQUAKES



SIR, I should like to comment on some mathematical aspects of the interesting article by Mr. D. A. Howells on "Structures to Withstand Earthquakes," published on page 346 of your issue of 13 March last.

In his model of an earthquake, the mass m is in motion horizontally under the action of two applied forces only, namely those due to the viscous damper and the spring. Measured in the direction of increasing x, these have the values $-a(\dot{x}-\dot{x}_g)$ and $-k(x-x_g)$ respectively, so that Newton's second law yields the equation

$$-a(\dot{x}-\dot{x}_g)-k(x-x_g)=m\ddot{x},$$

or

$$m\ddot{x}+a(\dot{x}-\dot{x}_g)+k(x-x_g)=0,$$

whence

$$m\ddot{\xi}+a\dot{\xi}+k\xi=-m\ddot{x}_g \quad . \quad \text{(A)}$$

where $\xi = x - x_g$.

Thus Mr. Howells' equation (1), repeated under the diagram, is faulty; nevertheless, apart from a misprint in the bracket at the end, his equation (2) is a correct solution of equation (A) above. This is given in No. 7 of Examples XXI on p. 298 of Lamb's *Dynamics* (Cambridge University Press, 1914), repeated here with changes of symbols to avoid confusion:

"Prove that the solution of the equation

$$\frac{d^2\xi}{dt^2}+\lambda\frac{d\xi}{dt}+\mu\xi=f(t)$$

is

$$\xi=-\frac{1}{\nu}e^{-\frac{1}{2}\lambda t}\cos\nu t\int e^{\frac{1}{2}\lambda t}f(t)\sin\nu t\,dt+\frac{1}{\nu}e^{-\frac{1}{2}\lambda t}\sin\nu t\int e^{\frac{1}{2}\lambda t}f(t)\cos\nu t\,dt$$

where $\nu=\sqrt{(\mu-\frac{1}{4}\lambda^2)}$."

The analogy with equation (A) is complete, since $\ddot{x}_g$ is assumed to be a function of t only. Mr. Howells' equations (3), (4) and (5) then follow correctly apart from a further misprint in the last. The example in Lamb follows Chapter XII in which the effect of dissipative forces, especially on oscillatory systems, is discussed.

I find Mr. Howells' electrical analogue difficult to understand. It is not clear whether q is a charge or a current, but on either assumption the dimensions of the terms in the equation given are mutually irreconcilable. A more exact analogue would perhaps be provided by the accompanying figure, in which a current generator supplies a current i_g to a series-parallel circuit.

Taking the potential of the base line as zero and that of the top line as v, the charges on the condenser plates as $\pm q$ and the current in the right-hand mesh as i, we have

$$v=\mathrm{R}(i_g-i)+\frac{q}{\mathrm{C}}$$

$$v=\mathrm{L}\frac{di}{dt}$$

Hence

$$\mathrm{L}\frac{di}{dt}+\mathrm{R}(i-i_g)-\frac{q}{\mathrm{C}}=0.$$

Differentiating and using $\dot{q}=i_g-i$, we have

$$\mathrm{L}\frac{d^2i}{dt^2}+\mathrm{R}\frac{d}{dt}(i-i_g)+\frac{1}{\mathrm{C}}(i-i_g)=0.$$

The analogy with the equation preceding (A) is obvious.

Yours faithfully,

R. SIBSON.

71 All Saints Road,
Sutton, Surrey.
12 April, 1959.

Editor's Note The misprints to which Mr. Sibson refers are: in equation 2 the bracket term should read $(t-\tau)$ and not $(t-t)$; and in equation 5 an additional term x wrongly appears in the expression to be integrated.

CRACK DETECTOR

Portable Unit for Ferromagnetic Materials

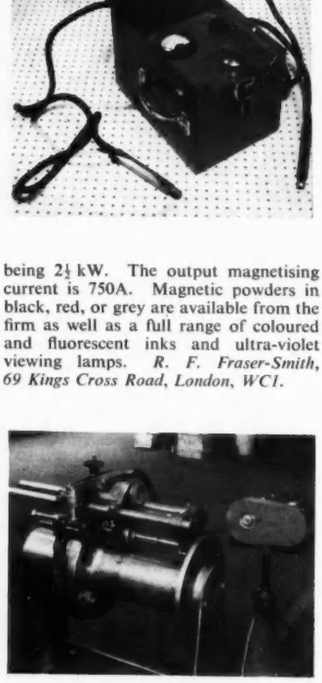
FOR detecting cracks on or below the surface of ferromagnetic workpieces, Fraser-Smith have produced a new portable unit weighing only 45 lb.

The instrument operates on the principle that when a workpiece is magnetised by passing a current through it, the lines of force are deflected at any discontinuity and can be observed by the use of fine magnetic particles spread over the surface. These particles may be discrete in the form of powder or applied as a suspension in a liquid. In the latter case the "inks" may be coloured or fluorescent; the fluorescent inks being viewed under ultra-violet light.

On the case of the instrument, which measures 13 in by 9 in by 10 in, are a carrying handle and feet on which it may be stood either as shown or with the handle uppermost. The use of a foot switch leaves the operator's hands free. A changeover switch allows supplies of either 100/120V or 200/250V single phase a.c. to be used, the consumption being 2½ kW. The output magnetising current is 750A. Magnetic powders in black, red, or grey are available from the firm as well as a full range of coloured and fluorescent inks and ultra-violet viewing lamps. *R. F. Fraser-Smith, 69 Kings Cross Road, London, WC1.*

BORER

For Restricted Positions



A BORING machine has been added to the Buma range particularly for work in restricted positions, as on the flanges of turbine shafts.

The boring bar runs in precision needle roller bearings which are carried in steady brackets located on each side of the coupling flange. A cross bracket casting, which can be adjusted vertically, is carried by two clamping units incorporating hardened steel rollers for locating the machine on the periphery of the coupling flange. This cross bracket is bored to take two ground steel bars, which lie parallel to the axis of the coupling shaft, and from which the two steady brackets are suspended.

One of these steady brackets incorporates a gearbox from which the boring bar is driven through V belts and pulleys. The drive to the gearbox is from a spearate power unit through a heavy-duty flexible shaft.

The gearbox also carries a feed mechanism which, through a bracket sliding on the two horizontal bars, imparts a feed to the boring bar. The feed is engaged by locking the feed screws with the thumbscrew on the feed bracket. A handwheel is used to position the cutter prior to boring.

Setting the cutter to size is achieved by using a micrometer which is clamped in position by a snap-over spring. The micrometer is direct reading and is calibrated from 1·5 in to 3·5 in. Other calibrations are available.

The cutters used are tungsten carbide and these are sharpened on a metal bonded diamond wheel attached to the pulleys of the separate power unit. *Buma Engineering Company Limited, Robson Street, Newcastle upon Tyne 6.*

CABLE TRACER

Also Locates Breaks and Short Circuits

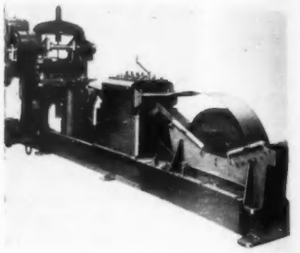
THE Metrawatt transistorised cable tracer can be used to discover the run of electric cables in walls or underground, and also to locate breaks and short circuits.

The instrument measures 3 in by 4 in by 1 in and weighs 7 oz. It contains an induction search coil and a capacitor pick-up, either of which can be connected to the amplifier to give an indication on the meter. Power is supplied by two 1·5V batteries. The amplifier is a three-stage unit with an adjustable gain from 5 to 10,000, the control being before the second stage. Head phones can be plugged in as an alternative to the meter.

To discover a conductor carrying an alternating current, the instrument is passed over the surface while held parallel to it, the search coil being in use. A conductor carrying 0·1A can be located at depths up to 1 ft. When using the capacitor pick-up, the instrument is held perpendicular to the surface; a cable running at 250V a.c. can then be detected at a depth of 1 ft. Short circuits are located using the search coil, and breaks using the capacitor. Cables running in earthed conduit are also detectable. *Metrix Instruments Limited, 54 Victoria Road, Surbiton, Surrey.*

STRIP CUTTER

Production Line Machine



A RANGE of automatic production machines to decoil, straighten, and accurately cut to length all sections of material from coils of up to 36 in wide is announced. A typical line is illustrated, with capacity for strip 15 in wide by 0·104 in thick (mild steel) from coils of 48 in diameter, weighing 2 tons. Any length can be measured and sheared, but a usual range is 6 in to 6 ft.

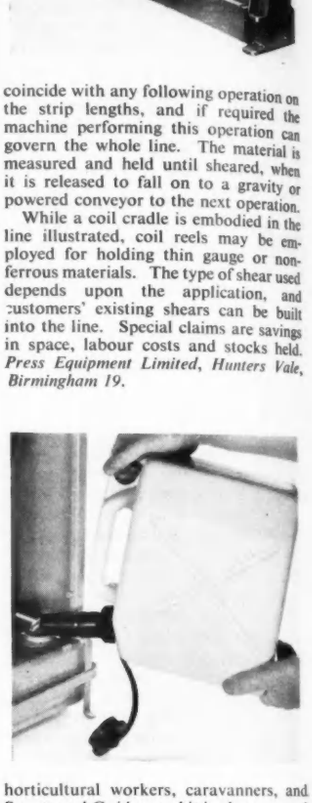
The coil cradle is power driven from the straightener transmission to ensure synchronisation, and the side plates and rollers are adjustable for coil width. The straightening and feeding head is driven from a self-contained motor, through an electromagnetic clutch and speed variator, with a worm and wheel reduction gearbox. Pinch rolls and straightening rolls are adjusted by crank handle for material gauge and straightening pressure, and roll parallelity is achieved by the use of triple gears and twin pressure screws.

Handwheel control is provided to set the speed of the cut-to-length line to coincide with any following operation on the strip lengths, and if required the machine performing this operation can govern the whole line. The material is measured and held until sheared, when it is released to fall on to a gravity or powered conveyor to the next operation.

While a coil cradle is embodied in the line illustrated, coil reels may be employed for holding thin gauge or non-ferrous materials. The type of shear used depends upon the application, and customers' existing shears can be built into the line. Special claims are savings in space, labour costs and stocks held. *Press Equipment Limited, Hunters Vale, Birmingham 19.*

CAN FOR LIQUIDS

Unbreakable and Non-Corrosive



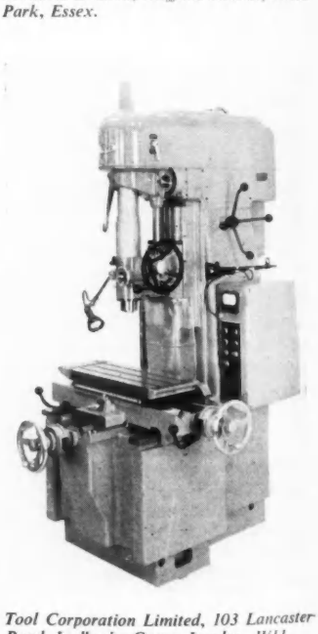
A NEW 1 gallon container for storing and transporting liquids has been introduced by Lacrinoid Products. Known as the "Handycan," it is blow-moulded in Rigidex high-density polyethylene supplied by British Resin Products Limited, which makes it rigid, virtually unbreakable, impervious to water, chemicals and oil, and completely resistant to corrosion.

The Handycan is light in weight and compact and is provided with a threaded pouring spout which press-fits into the handle when not in use. The threaded filler cap is securely attached to the container by a polyethylene strap so that it cannot be lost. The can does not rattle and will not dent. It is available in two colours—white and yellow—to assist identification of contents, e.g. white for water, yellow for paraffin. The colours are integral with the container and are therefore everlasting.

The can has been designed to meet the needs of a wide range of users—motorists, yachtsmen, campers, gardeners and horticultural workers, caravanners, and Scouts and Guides, and it is also expected to find many uses in and around the home. Although it is suitable for water, sea-water, paraffin, oil, liquid fertilisers, insecticides and most liquids in common use, it is not recommended for storing petrol, as there would be a loss of about 1 per cent per month of the contents, which would permeate slowly through the walls of the container. *Lacrinoid Products Limited, Stafford Avenue, Gidea Park, Essex.*

JIG BORER

Hardened Steel Ways Eliminate Gibs



A No. 3 jig boring machine has been announced by the Moore Special Tool Company Incorporated of Bridgeport, Connecticut, USA.

The machine has a table size of 11 in by 24 in with 18 in of longitudinal movement and 11 in of cross. The maximum distance from the table top to the end of the spindle nose is 20 13/16 in, while the quill housing itself has 11 1/16 in travel and the spindle quill 5 in of travel. The spindle speeds are infinitely variable between 60 and 2,250 r.p.m. and three spindle feeds are provided, these being 0·00075 in, 0·0015 in and 0·003 in per spindle revolution.

The machine is provided with hardened, ground and lapped steel ways so eliminating gibs and the table is completely supported throughout both longitudinal and cross travels. The accuracy of positioning is such that the greatest error in any one inch of the longitudinal or cross travel is 0·00003 in, and in the entire length is 0·00009 in. The squareness of the spindle housing in 12 in of travel is 0·00009 in. *Catmur Machine Tool Corporation Limited, 103 Lancaster Road, Ladbroke Grove, London, W11.*

DEEP DRAW PRESS

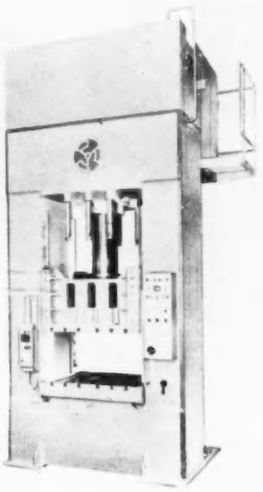
32 inch Stroke

PITZMANN AND PFEIFFER have just added a new size to their range of hydraulic deep drawing presses, designated Model DPZ315/800. This press exerts a force of 315 tons on the main slide, the stroke is 32 in, size of table 60 by 52 in, maximum opening between table and slide 52 in. The press is fitted with an hydraulic drawing cushion exerting a maximum force of 100 tons with a stroke of 12 in.

The main frame of the press is of welded steel box construction. The slide moves in four adjustable prismatic guides and has three ejector bars, the timing of which is adjustable. The main cylinder is a steel casting. The ram is fitted at the head with piston-ring type packings and the return movement of the slide is effected by the hydraulic fluid operating against these piston rings.

The hydraulic equipment is mounted in the head of the press and includes two high pressure rotary multi-piston pumps driven by 55 and 27 h.p. motors. These pumps are fitted with automatically operated pressure control, ensuring maximum speeds for the material being drawn. Drawing speeds and pressures are infinitely variable. The head of the press also contains the oil tank, all necessary control valves, and oil cooler for keeping the oil temperature within close limits. It is recommended that it should not exceed 60° C.

By means of the electro-hydraulic control unit three methods of operating the press are possible: inching, by the "start" push button with the optical safety guard inoperative; semi-automatic with the optical safety guard in the control circuit (single stroke); and fully automatic. The dwell of the slide at the top of the stroke can be adjusted from



2 to 20 sec, and at the bottom of the stroke from 1 to 10 sec.

The press is arranged so that reversal from downstroke to upstroke can take place either positionally, i.e. when a pre-set lowest point has been reached or, alternatively, when a certain pressure has been built up. Fast closing and return speeds make the press suitable for parts with great drawing depth. The drawing cushion can be operated completely independently of the main slide, with the advantage that the actual drawing operation can be interrupted at any stage. A cam-operated control valve allows for variation of drawing cushion pressure during descent of the ram. *Embassy Machine and Tool Company Limited, 248 Watford Way, Hendon, London, NW4.*

BOILER DAMPERS

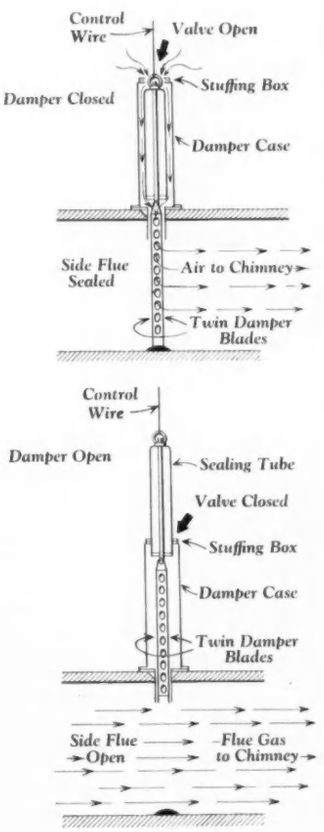
Seal Side Flues to Conserve Heat

THE sliding type of Air-Lok Damper is primarily intended for installation in the side flues of Lancashire boilers. It is specially constructed so that: (*a*) when the damper is in the fully closed position, no air can be drawn past it through the boiler and setting. Thus heat losses during stand-by periods are very much reduced; and (*b*) when in the open or working position no air can leak past the damper blades; thus draught losses are reduced and thermal efficiency increased.

The Air-Lok Damper consists of two parallel blades about 6 in apart held together by webs or spacers and forming a single casting which slides within a frame. The webs or spacers are perforated for the sake of lightness and also to permit the free flow of air in the space between the blades. Mounted on the frame with an air-tight joint is the cylindrical damper case.

The top of the damper itself is connected to the sealing tube which passes through a stuffing box provided at the top of the damper case. The stuffing box and the sealing tube together act as a valve which is closed when the damper is open, and open when the damper is closed. Thus it is evident that when the damper is in the closed position any air drawn past the damper blade nearest the chimney will be supplied through the valve and not through the boiler.

The damper blades and the frame in which they slide are cast in Meehanite type GE. The damper case is fabricated from $\frac{1}{8}$ in thick mild steel sheet and the sealing tube from 16 s.w.g. mild steel. Both items are of all-welded construction. A $\frac{5}{8}$ in diameter mild steel rod passes through the sealing tube, and is



connected to the damper blades at the bottom. *Combustion Equipment Limited, 61 Belsize Lane, London, NW3.*

PACKAGED COOLING TOWER

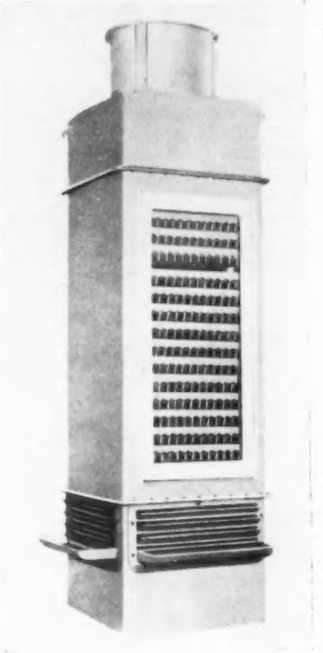
Glass Fibre Body

A NEW development in water cooling technique is the production of a complete packaged cooling tower small enough to be transported in a light lorry. It has a basin, shell and splash tray of resin-bonded glass fibre, a construction which while contributing to the lightness of the unit, eliminates the necessity of protective painting.

The tower operates on the induced draught principle; the fan and motor being mounted on the canopy expel the air from the top at high velocity. The cooling air entering at the foot at a relatively slow speed is circulated evenly over the base area and throughout the interior of the tower. The packing is of the Film Flow design which provides large heat transference in a small space. It is composed of a number of horizontal trays of parallel laths, each layer being at right angles to the next.

The water is discharged from spreader troughs which run along the entire length of the tower, and flows down the grid packing changing direction through 90° in every two inches down the whole depth film of water meets the ascending air without obstructing its course and as no drops are formed, the loss of water by entrainment is negligible. The internal packing, which is made of impregnated timber, is proof against attack by all known forms of wet, dry and soft rot organisms.

The unit is supplied ready for immediate operation, merely requiring to be coupled after the ground has been suitably levelled. Since the pond basin is an integral part of the tower no concrete or steel tank or foundations are necessary. Provision is made for anchor bolts for use when installed on a roof top



or in any location where high wind forces prevail. Built-in lugs are provided for crane slings.

The packaged cooling tower, which can be supplied in a range of self-colours, requires practically no maintenance and operating costs are therefore reduced to a minimum. Capacities range from 300 to 5,000 gallons per hour. *Film Cooling Towers (1925) Limited, Lionel Road, Kew Bridge, Brentford, Middlesex.*

BULK ELEVATOR

Portable, Variable Speed Unit

AN elevator for handling bulk materials at accurately regulated speeds has been developed by Russell Constructions.

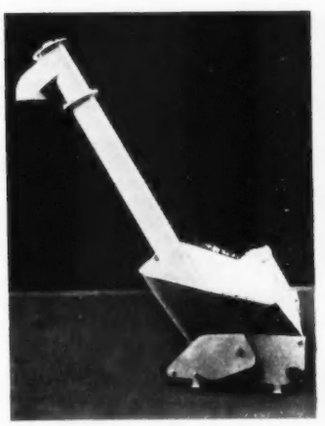
It operates on the screw conveyor principle and consists of a feed hopper from the base of which two opposed horizontal Archimedian screws lead the material into a slightly inclined elevating screw which in turn propels it up to a height of 5 ft 6 in. This height can be increased up to 11 ft by means of an extension piece which can be assembled or dismantled in less than 5 min.

The unit is powered by a small electric motor driving through an infinitely variable torque converter, by means of which the operator can regulate the output speed. When fitted with a 1½ h.p. motor the range is from 3 to 12 tons per hour, and with a ¾ h.p. motor, a range of ½ to 3 tons is obtained.

The feed hopper has a capacity of 4½ cu. ft (slightly more than the contents of an average sack), and as its feeding height above ground level is only 18 in, the physical effort of loading is small.

The machine can be easily dismantled for cleaning, an operation requiring only a few minutes and which can be carried out without the use of any tools. All the bearings of the spiral units are sealed to prevent any possibility of the material being contaminated by lubricant.

The machine is said to be quiet in operation and to raise no dust. The horizontal screws run at a fairly low speed and effective scavenging of the hopper with no possibility of cavitation is thus assured. The elevating screws, by rotating at four times the speed of the horizontal set, take advantage of the centrifugal forces generated to improve output and efficiency. The elevator can



in addition to handling be used for mixing two different materials while they are being elevated. By partitioning the hopper into two compartments and feeding two different products into the respective compartments, a one to one mix is obtained. Furthermore, the materials can be mixed and elevated in any desired proportion by varying the pitch of the screws of the spiral feeds.

The unit is mounted on trolley wheels and can easily be moved to different locations by the operator. It can be used to elevate almost any kind of bulk material. *Russell Constructions Limited, 9 Adams Street, London, WC2.*

In our description of the Besco plate bending rollers (issue of 10 May, page 454), the maximum capacity of the TR model was quoted in the text as mild steel plate up to 1¼ in thick. This should have been ¼ in thick.

HANOVER FAIR *A Market Place for European Industry*

The German Industries' Fair at Hanover is a market for engineering products where sales are completed on the stands. For one firm, sales made last year at the fair amounted to 70 per cent of their annual output; this year many exhibitors thought business even more active. Around the 15 *Halle* and the 30 acres of open space, 4,600 exhibitors had displays there. The fair opened on 26 April and closed on 5 May.

The range of exhibits included both domestic consumer goods and the heaviest products of engineering industry; from kitchen equipment to steelworks ladles, from plastics bottles (in an infinity of shapes) to harbour cranes and, transversely, from pumps and motors to typewriters and adding machines. Textile machinery and machine tools were two peculiar omissions—in both cases because of specialised fairs being held elsewhere in Europe during 1959.

In a separate display, held at Hanover's airport, the German aircraft industry exhibited the components, instruments and equipment they are already putting into the world's markets. Small aircraft—of the executive type—were in great evidence and were used for a taxi service between the airport and the fair. By the end of one flight in an air-taxi at least one visitor—a South American—was asking his fellow travellers how much such a 'plane would cost.

Because of the strict division into trade groups allowed to exhibit in each part of the fair, Hanover is in effect a concentration of trade fairs all held in close proximity and within the same short period. It is claimed by the organisers to be an international fair, but with only 17 per cent of the exhibitors coming from outside Western Germany it is still very much a German industries fair—as it was when it originally began. Visitors flood into Hanover. From all over Western Germany they come and, in addition, this year, the Scandinavians were particularly noticeable. One day was set aside especially for African buyers, but there were hardly as many representatives from the Middle and Far East as might have been expected following Germany's recent commercial propaganda there.

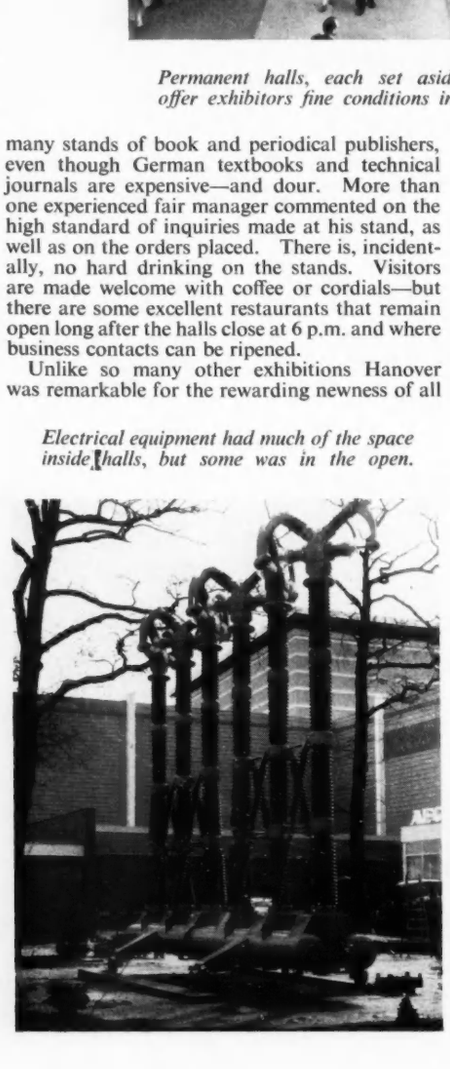
As at other continental exhibitions, a notable feature was the interest of the local people, including both youth and womenfolk. True this does not bring in business directly, but it is symptomatic of an industrial well-being. An allied sign was the great activity around the many stands of book and periodical publishers, even though German textbooks and technical journals are expensive—and dour. More than one experienced fair manager commented on the high standard of inquiries made at his stand, as well as on the orders placed. There is, incidentally, no hard drinking on the stands. Visitors are made welcome with coffee or cordials—but there are some excellent restaurants that remain open long after the halls close at 6 p.m. and where business contacts can be ripened.

Unlike so many other exhibitions Hanover was remarkable for the rewarding newness of all the products shown. It was not that all the stands were full of novel designs—for many products this was hardly to be expected—but there was a notable absence of out-moded lines. None of the exhibitors who went to Hanover—wherever their origin—displayed goods just because they had been successful a few years ago.

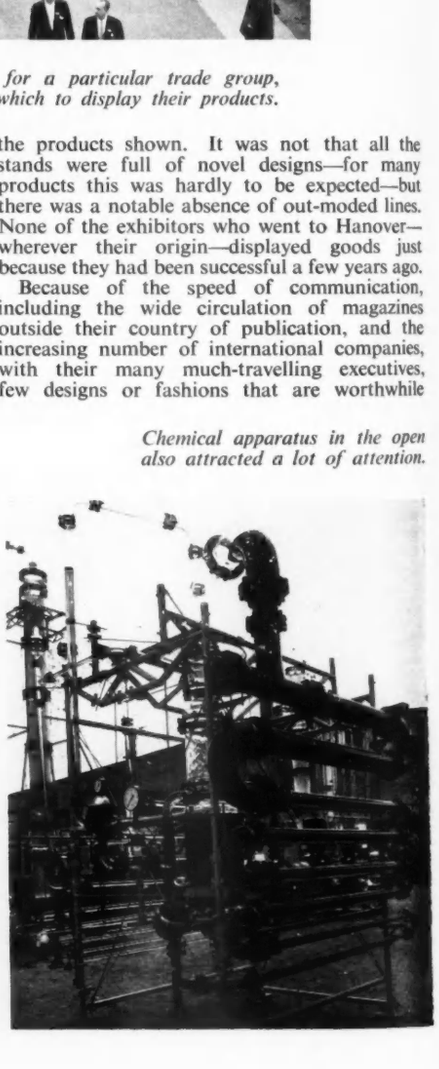
Because of the speed of communication, including the wide circulation of magazines outside their country of publication, and the increasing number of international companies, with their many much-travelling executives, few designs or fashions that are worthwhile

Permanent halls, each set aside for a particular trade group, offer exhibitors fine conditions in which to display their products.

Tall cranes were a feature of this year's fair, providing this effective picture.



Electrical equipment had much of the space inside halls, but some was in the open.



Chemical apparatus in the open also attracted a lot of attention.

Within the 16 halls and around the 30 acres of "open space" 4,600 exhibitors have stands at Hanover Fair. There is also parking space for between 35,000 and 40,000 cars.

remain the monopoly of one region for long. Common trends are to be found in most countries simultaneously.

Nor, at Hanover, were show gimmicks much in evidence—neither were the majority of those that were there much appreciated. A radio-controlled dumper turning circles without a driver drew hardly a second glance. On the other hand, a Demag remote-controlled overhead crane was the subject of much attention; so were the same company's mobile cranes that were being driven vigorously around a display pen by their younger female staff.

The halls on the fair site—which is about 12 km from the centre of the city—are all permanent. Some, like those used for machinery and "tools" are unbroken by partitioning and each has an uninterrupted floor space of about 600 ft by 200 ft. Other halls are smaller, but these generally have balconies or upper floors for additional stands and, in two cases, the halls are multi-storeyed. In many halls, especially those for mechanical engineering, the exhibitors chose a simple, matter-of-fact arrangement for their products with little or no attempt at "display." In contrast to this, the five or six halls devoted to electricity—generating plant, radio and television, power distribution and light fittings—all had elaborate stands. This was also true of the *Büroindustrie Halle*; there the Germans demonstrated their love of order and method by an almost unending display of complicated filing systems. Would anyone stay where such abominations were installed?

Many of the larger units in German industry—Krupp, Mannesmann, Demag, and Brown, Boveri and Cie AG (of Mannheim)—have their own permanent positions as well as extensive open air sites. In their pavilion Demag had some particularly fine models (scale, 1 in 30) of recent steelworks, rolling mills and power stations for which they have been contractors. A railway link leading to many of the halls enables nearly any size of exhibit to be taken to Hanover. All the companies in the iron and steel group had some massive exhibits—like Klöckner's 25 ton casting in high tensile steel of a stern post for a 16,500 ton motor tanker.

At this fair prestige displays attracted relatively little attention and hardly anyone gave more than a cursory glance at complete electric locomotives. An exception, however, was the inquisitive interest in the Krupp-BBC reactor systems that were represented by models and display diagrams. A visitor to Hanover was left in no doubt of German industry's capacity to undertake nuclear engineering. The UKAEA stand, however, presented an air of quiet confidence; it is patently easier to make claims when you have already been successful than to assert that you could be if. . . .

But the Hanover fair is nothing if not purposeful and, if Britain were ever a nation of small shopkeepers, then Germany is a nation of small industrialists. It was perhaps for this reason that most activity was to be found among those exhibits which, for a relatively low capital investment, would enable a small producing firm to be established. This may have accounted for the crowds around the plastics and rubber-working machinery but comment also suggested that there, if in no other hall, were to be found equipment in advance of anything yet seen. Some of the big mixers and moulders were particularly impressive for the easy movements they employed: gates and doors closed with a precision that was a delight to observe.

A new hall, a small one, was given over to "die gute Industrieform." The Germans, like many others, seem to find the deliberate expression of good style difficult and the few exhibits hardly filled the hall. Some of them, moreover, were bad—the cutlery, for example; but a bacon slicer appealed—and far better designs were to be found elsewhere. Among the good styling that should be mentioned were the cabins on some of the mobile cranes.

The aircraft industry have an additional display at Hanover airport. Small executive and taxi planes were in great evidence.

There were also, however, some horrible examples of poor styling to be seen, especially among the domestic equipment, and the palm must surely go to one television manufacturer. His machine was encased in a huge piece of wrought and over-polished timber, looking not unlike the worst of Victorian furniture overlaid with plenty of gilt "decoration."

But the lasting impression of the fair was of a vast range of well-designed equipment attracting selling to discerning buyers.

A small number of British firms go to Hanover. Their stands attract attention from continental and world buyers.

Tale of the Telephone

To commemorate their seventy-fifth anniversary, Standard Telephones and Cables have published a brochure illustrating the purpose of the firm, which was born only eight years after a Scottish teacher of acoustics, Alexander Graham Bell, " in a homespun and rudimentary instrument of reeds, electromagnets and telegraph keys, hit upon the principle of communicating speech over a wire." Fundamentally, the story of STC is the story of the telephone. It is most attractively told in what is, even by modern standards, an outstanding commemorative brochure.

STC was founded in 1883 by J. E. Kingsbury. He was Western Electric's first agent in England. Western Electric were already a name to conjure with in the telephone manufacturing field. The legal tussles between the rival Bell and Edison interests which marked the first years of the telephone's life had been resolved in 1880 with the Edison-Bell merger which resulted in the formation of the United Telephone Company, in this country, and the emergence of the American Bell Telephone Company, in the United States. In the following year all the separate companies making telephone apparatus under licence from the American Bell Telephone Company were consolidated as the Western Electric Company. ABTC retained control, and the fruitful partnership began between operating and manufacturing company, which, in one form or another, has stood the test of more than three-quarters of a century. When the ABTC was merged into the American Telephone and Telegraph Company in 1899, Western Electric remained virtually the sole supplier of equipment to the Bell system, and, indeed, at the time of Kingsbury's arrival at Moorgate they supplied most of the rest of the world.

In 1898 Kingsbury took over a factory at North Woolwich. The factory occupied a riverside site of some 4¾ acres, with a manufacturing space of 107,000 sq. ft. At the outset the power cable plant consisted of two lead presses, one armouring machine and four impregnating tanks. Fewer than a dozen men were employed, and the lead for the presses was melted in cauldrons over open fires at one end of the shop. Cable was supplied to factory owners and other industrial users who generated their own electricity. Woolwich is now STC's senior factory, on a site of more than 13 acres, with a floor space of 563,000 sq. ft. Although it is not the largest factory in the group, it is described as " the real cradle of the company in its modern form."

As the story unfolds itself over 100 glossy pages, the company's growth pattern emerges, product by product, until it became the largest unit in Europe's telecommunications industry, with nine factories, several laboratories and research departments, and a payroll of 25,000.

Orpheus and the Bloodhound

An agreement has been signed in Koblenz between the Federal German Ministry of Defence and Bristol Siddeley Engines Limited providing for the manufacture under lincence in the Federal German Republic of the Bristol Siddeley Orpheus 803 turbojet engine. The engine, rated at 5,000 lb thrust, is the power plant of the Fiat G-91 lightweight tactical strike fighter. This aircraft has been specified as the standard NATO machine in this role and will be manufactured under licence by Germany. The Orpheus 803 is fitted in some 50 aircraft of six different types, including the Breguet Taon, the Folland Gnat and the Lockheed Jetstar utility jet transport. In all, it has been specified as the power plant for 14 different aircraft.

A new version of the Bristol-Ferranti Bloodhound missile system has been ordered by the Royal Air Force for use in the defence of the United Kingdom. This means that the Bloodhound system will be used as a single weapon system, and be adapted to keep pace with technical change. This was the policy followed during the war with aircraft such as the Spitfire, and is anticipated to yield a number of operational and economic advantages. Thus the training programme for the specialists who will man the missile stations can be largely common within the series. This procedure not only saves time and money, but also ensures a longer useful " life " of trained men. The new missile has a much increased operating range in altitude. The more advanced techniques which it embodies will also ensure greater accuracy in these increased ranges and improved low altitude performance to counteract the threat of low-flying targets.

Reacting Chemicals

The results of the two largest companies in the chemical industry, Imperial Chemical Industries and E.I. du Pont de Nemours, provide a useful guide to the impact of the recession on both countries.

ICI's turnover was not appreciably lower than during 1957: sales to external customers by the group as a whole totalled £462·68 million, compared with £462·89 million in 1957. Du Pont's sales were substantially down: $1,829 million compared to $1,965 million. The decline of 7 per cent from the 1957 record level resulted from a fall of 6 per cent in the physical volume of sales and of 1 per cent in the company's index of selling prices. Earnings were down by nearly 20 per cent, $225 million compared to $281 million. ICI's earnings were also substantially lower, £51·5 million compared to £61·5 million in 1957, a fall of 16 per cent.

ICI's sales in the home market in 1958 were slightly greater than the previous year, and their sales of plastics, paints and leather cloth were at high levels and in spite of bad weather there was an increase in fertiliser sales. There was a substantial fall, however, in sales to the textile, building, coalmining and steel industries, all of which were severely affected by the recession and there was also a very marked fall in the sales of titanium due to the reduced amount for military aircraft. Despite the general world recession, ICI's exports to the United States increased by nearly 2 per cent in 1958 to £73·8 million. The fall in profits almost entirely resulted from rising costs, resulting from increases in wages and salaries, in transport charges and in the prices of materials consumed. This obviously affected the British company much more than du Pont, and according to the directors' report, was due principally to the emergence of " a factor not experienced for many years, namely, the operation of a number of plants at levels appreciably below their full capacity."

Both companies assessments of their prospects anticipate a general improvement in the economic weather. Du Pont states that the demand for the company's products reached its lowest point in the first three months of 1958; thereafter, sales increased in each successive quarter and for the final three months they were the highest in the company's history. The current year is expected to be one of moderate expansion; expenditure for new plants during 1958 amounted to $231 million compared with $220 million. Four new plants were completed and began operation during the year and the output of the group is therefore expected to rise substantially.

Pye Scan the World

The Government of the Belgian Congo have ordered a Pye instrument landing system for both the Elisabethville and Leopoldville airports. This award is a tribute to the company and a welcome development in view of the recent controversy on the relative merits of British and American systems.

One of the features of the Pye ILS most appreciated by airport administrators is the ease with which ground installation can be erected by local labour. They have now installed their instrument landing systems at Geneva International Airport, Prague Airport, and Moscow Airport and the Indian Air Force are at present completing their first installation.

Another important contract recently awarded to the company is for the provision of a radio communications system in Persia, between Kharg Island in the Persian Gulf, the oilfield at Gachsaran and the Agha Jari oilfield. It was placed by the Iranian Oil Operating Companies and consists of 12 channel v.h.f. systems using frequency modulated multiplex radiotelephone equipment.

Countercurrent Expansion

Expansion schemes continue to be reported despite the lull in industrial activity. Two new factories were opened, one by the Beldam Asbestos Company Limited, and the other by the Sperry Gyroscope Company. Beldam were founded in 1889 by Robert Beldam as " general merchant, ships' store furnisher and sole manufacturer of A1 asbestos metallic engine packing." Shortly afterwards the founder adopted the trade name Lascar and secured his first Admiralty contract. In 1922 his two sons developed the Auto-Klean filter. The two businesses expanded side by side, at a high rate during the war, and a new factory of 100,000 sq. ft has now been built in the garden and orchards of the founder's home at Hounslow.

The company's product policy has evolved steadily. Beldam now manufacture a wide range of steam and water packings, including one—Hatchtite—which is used for hatch sealing and remains resilient over many years of service. They also make moulded rings for high pressure hydraulics, including some made of Fluon, which are impervious to all known acids and alkalis. Auto-Klean have introduced a filter, the Micom, which combines a fine mesh self-cleaning unit with a clarifier in the form of a paper element which gives filtration down to micronic proportions. Another, the Koton, is suitable for handling fluids containing radioactive particles. An associated company, the Submerged Log Company, make instruments including the Chernikeeff Log and electronic log, one of the legacies of Captain Chernikeeff, late of the Imperial Russian Navy.

Sperry Gyroscope opened a new factory at Bracknell new town, Berkshire, for the manufacture of guided missile components. Over 1,000 people are employed there on secret work demanding a high standard of skill and precision. Much of the work is on the guidance system of Blue Streak, Britain's ballistic rocket and the control system of the Seaslug ship-to-air guided weapon adopted by the Royal Navy. At the opening ceremony Mr. Aubrey Jones said that the emphasis had now changed, from quantity to quality, and that this meant greatly increased expenditure on research and development.

Foothold for Johnson Matthey

A substantial interest in the largest refiners and manufacturers of precious metals, Metalli Preziosi S.p.A. of Milan, has been acquired by Johnson, Matthey and Company. The two companies have been working closely together for many years and ten years ago Metalli Preziosi became Matthey's general representatives in Italy. In their announcement of the agreement, Johnson, Matthey say that it provides for technical as well as commercial integration and gives the Italian company access to the resources of their research organisation.

Metalli Preziosi have been established for over a century. They have their head office in Milan and their principal refineries and production centre in the new industrial zone of Paderno Dugnano near Milan. For Johnson, Matthey it will mean a very strong foothold in the Common Market area.

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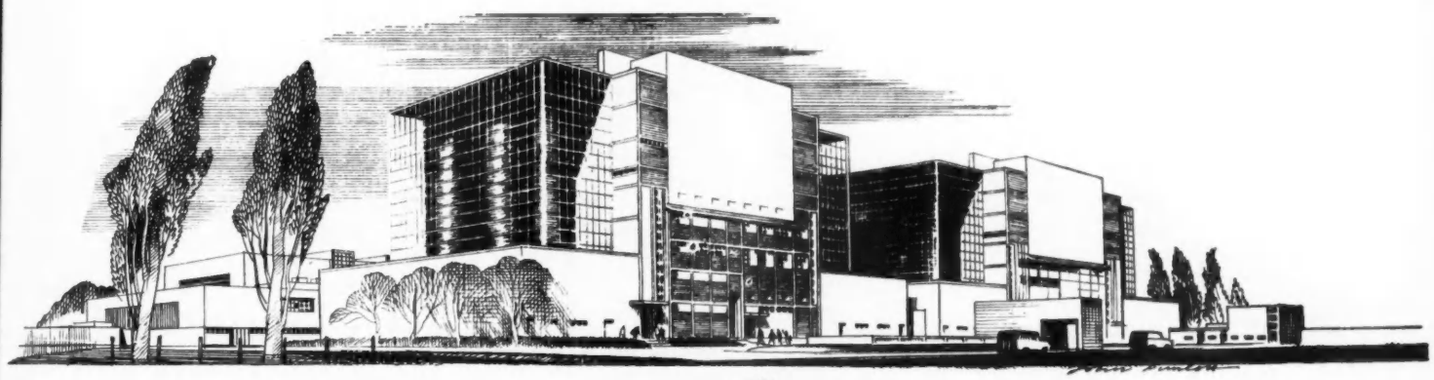

Bradwell, Essex, has leapt into fame as the site of the first commercial nuclear power station in the world to be built by N.P.P.C. Eight names make The Nuclear Power Plant Company Limited. N.P.P.C. thus combines the resources of eight specialist companies whose individual skills are co-ordinated to form a unified team capable of undertaking the construction of complete nuclear power stations throughout the world.

Bradwell nuclear power station will have a guaranteed output of 300 Megawatts. It is being built by The Nuclear Power Plant Co. Ltd. for the Central Electricity Generating Board.

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Causes of Unrest

The large number of small strikes during the past few months suggests a deep underlying cause of unrest. The fact that many of the strikes have been over interunion disputes, that most have been unofficial and that union leaders have either condemned the rank and file or been condemned by them rather confirms this feeling. Perhaps the most startling was the refusal of the executive of the AEU to listen to their president, Mr. William Carron, over the twin issues of wage increases and the 40-hour week. He could only get 20 of the 54 members to support him. The same powerlessness of union leaders was apparent in most of their interventions in unofficial strikes.

Perhaps the most determined revolt against national leadership has taken place in South Wales where 100 officials of the 25 branches of the British Iron, Steel and Kindred Trades Association at the three Port Talbot works of the Steel Company of Wales are prepared to resign unless the union's national executive agrees to receive a deputation from the joint group to hear their appeal against the recent decision of the executive to depose five officials from office for life for their part in the four-day strike in February. In shipbuilding, unofficial strikes continue to handicap the industry. The latest is a strike of 1,500 boiler makers at Cammell Laird's Birkenhead yard, over a disagreement on who should fit sections of cargo hatch trunking on the liner Windsor Castle. At the Southwick, Sunderland, yard of Austin and Pickersgill, 287 boilermakers struck last week over the sacking of a plater for " careless workmanship." At the Cowley works of Morris Motors, 300 men in the paint shop stopped work because " a material in a spraying process on particular lines is too hard to rub down." At Jaguar's works there was an interunion dispute as to who should drill holes, which resulted in a three-day standstill. An unusual cause of a strike was at the Barnsley and Wombwell glass works of Wood Brothers, over a clock fitted to a machine " to test its efficiency." It was described by a workman as a " big brother " (it records idle time) and no amount of talking by the management could convince the men it was in the cause of efficiency. There had been no strike since the company was founded 131 years ago.

Attempts are being made by some union leaderships to eliminate demarcation problems. The National Federation of Building Trades Operatives, for example, have held a conference of 19 building unions to discuss " the impact of new techniques on the industry." Others, such as Mr. Carron (who has nevertheless received a vote of confidence in his reelection as president of the AEU), use strong language to denounce " mischief makers " who wilfully reject union instructions and organise unofficial strikes. But underneath it all is the feeling that jobs are no longer secure, that unemployment will rise and standard of living will fall. Labour is becoming restive because it is afraid.

Educational Option

Success for the new Diploma in Technology ultimately depends on its ability to establish a standard which will make its acquisition as valuable as that of the older established academic qualifications. Not only have significant numbers to be attracted to take it, to give it an initial prestige (even initial fashion will do at this stage) but its recipients must prove that they can hold their own and so prove the diploma's worth. This will be no easy matter and will take time as well as patience.

In his foreword to the second report of the National Council for Technological Awards published last week Lord Hives the chairman of the council, says that 2,518 students are now following courses leading to the diploma at 20 colleges compared with 965 students at 11 colleges in November, 1957. The first diplomas have been awarded and soon the annual rate of awards will be of the order of several hundreds. But in certain areas of engineering the numbers being trained still appear to be inadequate.

Speaking at the annual meeting of the Institution of Chemical Engineers, Sir Hugh Beaver, the retiring president, said that the number of chemical engineers likely to be trained by 1966 would fall far short of requirements. The rate of expansion in the chemical industries is nearly twice the national average, and the institution has recently calculated that some 5,000 chemical engineers would be needed in 1966.

Careers Market Place

The National Education and Careers Exhibition opens at the National Hall, Olympia, London, on 26 May. It is the first time an exhibition of this type has been held in this country and it has attracted an unusual degree of support and interest. All available space had been sold almost nine months before the opening date and many applications have been turned away.

It is being organised by the National Union of Teachers with the full support of the Ministries of Education and Labour, the local education authorities and such bodies as the Federation of British Industries, British Employers' Confederation and the TUC. Her Majesty the Queen is patron. The NUT's Education Section will occupy some 35,000 sq. ft and will cover " all aspects of modern education from nursery school to university and adult education." The exhibition is being designed by Mr. Eric Lyons, in association with Mr. Hulme Chadwick.

Under Instruction

Imaginative and systematic training of all grades of staff and operatives, including apprentices, has had the active support of the British Iron and Steel Federation for a number of years and no trade association has kept closer or more consistent contact with members and related industries than has the federation's training section. The latest issue (No. 35) of *Training*, the federation's occasional periodical on the subject, draws attention to the need for a grasp of a foreign language in order to get the best out of an exchange scheme. In this case it has been an exchange scheme for young managers and the training committee offers a German language course for the exchange trainee.

Nearer home, Stewarts and Lloyds Limited have recently opened a new training centre at Bilston. The company set up a training department in 1944 and the company's works and offices are grouped for training purposes into areas. In each of these there is an area training officer. The Bilston centre was formed in 1945. The new building offers better facilities for training and scope for taking more trainees. Apprentice training on a national scale has recently been the subject of debate in the House of Commons and it is possible that nation-wide measures may be taken to tackle this problem.

Cambridge Business School

A one-year course on the principles of industrial management has been instituted at Cambridge University. Reference to the course was made in our leader of 27 March. The proposals originated from the Department of Engineering of the university whose head, Professor J. F. Baker, described the decision as " probably the first major attempt to institute a course similar to the masters degree course of the Harvard Business School and other American universities. Since the course is intended for men who have either scientific or technological qualifications it may have considerable future impact upon the shortage of technologically literate administrators."

The course is intended for students of high quality, who have attained a standard in mathematics " which will enable them to deal with complex problems in the analysis of industrial activities." The board proposed that all candidates should be required to have obtained " first or second class honours in either Part I of the Mechanical Sciences Tripos, or Part II of the Mathematical Tripos, or Part I of the Mathematical Tripos and one part of some other Tripos or Part I of the Natural Sciences Tripos having attained a standard not lower than the standard of the second class in whole or half-subject mathematics therein.

The syllabus suggested by the board includes quantitative analysis and control—the application of scientific method to industrial problems, the design of experiments, the application of statistics to engineering processes, and so on; human behaviour in industry; economics, finance and accounting and the social environment of industry. A committee of the Faculty Board of Engineering has been formed to advise on all questions affecting the course and examination.

Courage in the Boiler Room

The *London Gazette* recently carried the announcement of the Queen's Commendation to two Naval men for courageous action during an accident in the boiler room of a frigate. The two men are Engineer Lieutenant H. W. Polhill and Petty Officer Engineering Mechanic M. D. Thomas.

An oil fuel heater joint blew out between Petty Officer Thomas and the access ladder while he was senior rating in the boiler room. This released oil fuel at a high pressure and at 200° F. Knowing the grave risk of fire and explosion, says the citation, Petty Officer Thomas (who was within ten days of release from his engagement with the Navy) acted with calmness, efficiency and complete disregard for his own safety. He kept to his post, informed his senior officer of the accident and when the latter arrived had succeeded in isolating the joint. Lieutenant Polhill, though sustaining burns on legs and face, shut off emergency valves, returned to the boiler room and took charge of remedial operations. Petty Officer Thomas has since left the Service.

Wearin' o' the Green

Not long ago a young man wrote to us from Northern Ireland to ask if he might receive ENGINEERING at the special students' rate. Naturally we were happy to comply, provided that the applicant could confirm his standing as a *bona fide* student. His standing did in fact appear to be somewhat questionable, since his letter was headed: " H.M. Prison, Belfast."

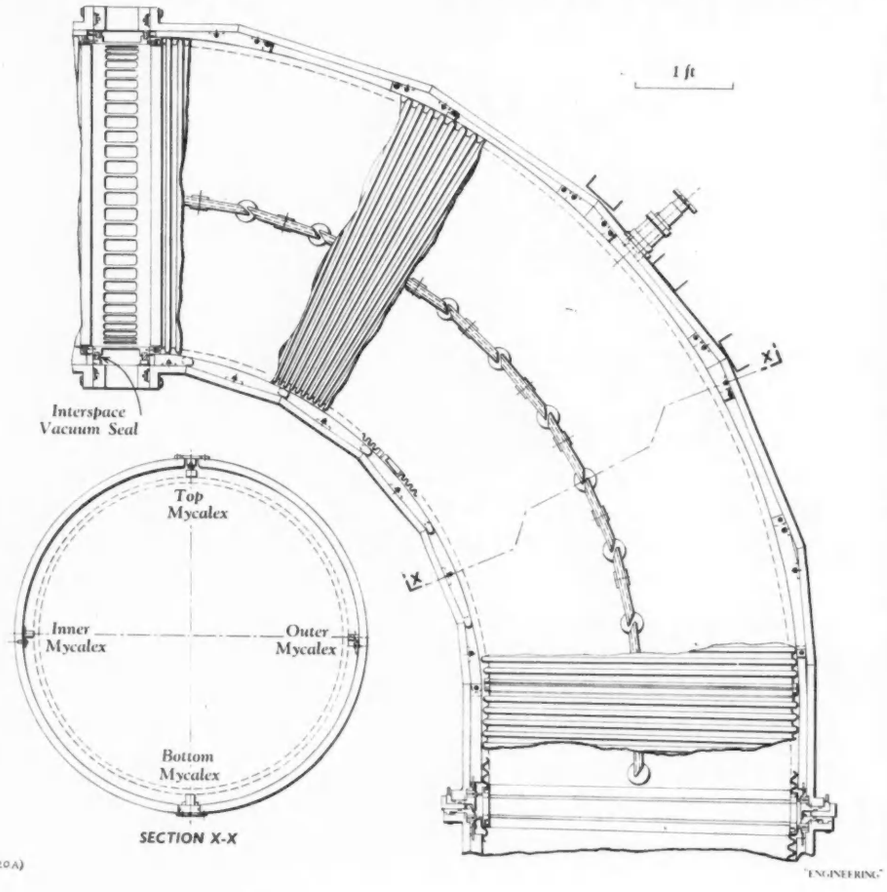
Correspondence with him and later with his university revealed that he was a first year student in the university's faculty of applied science and technology, but in 1957 the police had apprehended him under the Special Powers Act and he had been held ever since. This Act of the Northern Ireland Parliament enables the authorities to detain in prison without charge being preferred persons whom they suspect of being associated with Republican activities. Being uncharged, he was regarded as a student in good standing with the university, whose studies had been interrupted, and indeed first-year examinations had been conducted in prison for his benefit. He succeeded in satisfying the examiners, and on release he will continue his lectures. He has been interned now for more than 20 months.

It is not unlikely that he will see this note, since in the circumstances we felt he qualified for the special subscription rate. We do of course have a green cover.

Thermonuclear Engineering

THERMONUCLEAR research, though closely linked with academic scientific inquiry, is directed towards a practical social purpose—the production of electric power. For this reason and because of its essentially empirical character, such research may justly be regarded as engineering. But apart from any partisan considerations, many of the most formidable problems presented by these investigations have required engineering solutions, involving experience in the design of transformers, condensers, switching equipment, instrumentation (diagnostic tic), and vacuum plant. There is also reason to believe that the apparatus by which thermonuclear processes are being studied now may bear some resemblance to the apparatus by which they will eventually be put to use, so that the technical development undertaken for these experiments may provide valuable background for the practical power plants of the future. Conversely, as racing cars test and promote advances in automobile engineering generally, so may thermonuclear studies accelerate developments in electrical and vacuum engineering. One engineering group, Associated Electrical Industries, has already played a considerable part in this work: the AEI Research Laboratory has made a substantial contribution to the fundamental study of plasmas with its toroidal pinch apparatus Sceptre III; and Metropolitan-Vickers, a member of AEI, were principal contractors in the design and construction of Zeta. Last week in Atomic Review the fundamental work reported at the recent BNEC Convention on Thermonuclear Processes was summarised; the following notes are concerned with the engineering design and modification of Zeta, and a rival fast-pinch apparatus will be described in a further article.

Fig. 1 Constructional features of continuous liner system in Zeta 1A.



Engineering Problems Outstanding

The ingenuity shown in all the magnetic containment systems devised for thermonuclear research has been considerable. The experimental results obtained indicate that the behaviour of fully ionised plasmas is more complex than can be accounted for by existing theories. With so many gaps in our knowledge, it is too early to say that any one approach is likely to provide the best road towards the goal, and a great deal more work still remains to be done. This research is not confined to the field of physics, since engineering problems also require study. In general terms, the engineering problems are: (*a*) the economic storage of energy in the tens to hundreds of megajoules region; (*b*) its switching into and out of circuit, in some cases in very short times and with reactive loads; (*c*) the design of a magnetic-field system to withstand the forces associated with establishing the high fields required; and (*d*) the problems of circuit protection. (Paper 2903, A Review of Work Towards Nuclear Energy from Controlled Thermonuclear Reaction, D. W. Fry.)

Zeta Modifications

Experience with Zeta in 1957 showed that it was desirable to improve its performance in both scientific and engineering aspects. Modifications undertaken aimed at the following improvements: (*a*) reduction of liner maintenance difficulties; (*b*) improvements to the vacuum system to reduce contamination of the discharge; (*c*) improvement of the axial field to reduce damage to the liner by arcing and improve stabilisation of the discharge; (*d*) circuit modifications to increase the rate of energy input to the discharge and to improve control; and (*e*) improvement of diagnostic facilities. In its modified form the machine is known as Zeta 1A. (Paper 2930, The Modification of Zeta in 1958, J. T. D. Mitchell, *et al.*)

Continuous Liner

Operation at gas currents above 160 kA had previously been limited in duration to prevent excessive damage to the liner system, which, nevertheless tended to be short lived. Thus instead of 48 water-cooled aluminium liners insulated from each other by polytetrafluorethylene, the new liner was to be continuous and of sufficient resistance to ensure

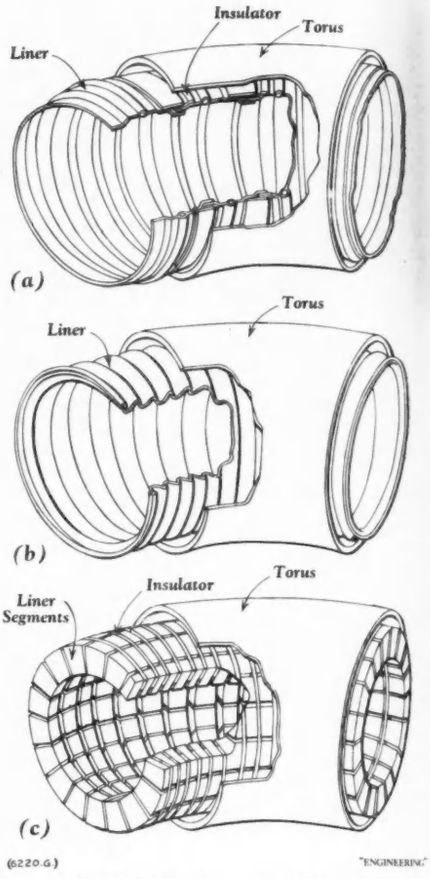


Fig. 2 Three torus liner systems: (a) sectional liner system, (b) continuous liner system, and (c) segmented liner system.

that its shunting effect on the discharge would be small. This construction was chosen to inhibit breakdown of the main gaps in the torus body. Materials testing had already shown that stainless steel had a shorter conditioning period and a reduced tendency to arc after conditioning than other common materials. The problems were to achieve a sufficiently high resistance and to assemble inside the aluminium torus a second tube which was required to be continuous and insulated from the torus wall. In Zeta the discharge resistance is of the order of 3 milliohms, and it was considered that a liner resistance of 25 milliohms would be satisfactory, resulting in peak liner currents of 120 kA at the voltages envisaged, that is 3 kV per turn. Calculation showed that a simple tube of the required dimensions, fabricated from 15-mil stainless-steel sheet, would have a resistance of only 5 milliohms, but it would also be too weak to withstand the pressure differential resulting from vacuum failure. Both these effects were overcome by corrugating the surface of the tube ($2\frac{1}{2}$ corrugations per inch, each 0·7 in deep). The bellows construction simplified bending the straight assemblies to a toroidal shape, while the constant resistance per turn distributed the liner current evenly over the liner cross-section. The liner was manufactured by forming and welding techniques developed for pipe expansion joints, suitably adapted to the size and gauge of sheet required. The new torus and liner system is shown in Fig. 1. The liner is made in three parts for each quarter torus, and is insulated from the torus body by Mycalex (grade LDS) spacers. At the window blocks slotted stainless steel rings (colanders) allow for vacuum pumping of the inside of the liner and for direct access to the discharge for experimental purposes. Instead of water cooling the outer surface of the liner has been oxidised to increase radiation losses. (Paper 2930.)

Torus Design

One of the principal problems of heavy-current discharges is the contamination of the plasma by material eroded from the walls of the discharge tube. Erosion may occur by thermal evaporation, sputtering and—in the case of metal walls—the formation of arcs. It appears that, for stable discharges of long

Fig. 3 Continuous liner for Zeta 1A designed by AERE in conjunction with Teddington Aircraft Controls Limited.

TABLE I.—*Summary of Torus Designs*

Type of torus	Heat transfer	Heat pulse	Axial field exclusion	Longitudinal stability	Power arcs	Unipolar areas	Ease of fabrication	Other features
Glass and ceramic	Bad	Bad	None	None	None	None	Fair	
2-gap metal	Good	Good	Good	Good except at gaps	Bad	Bad	Good	
Multi-gap metal	Good	Good	Good	Bad	None with stable discharge	Bad	Good	
Glass-lined metal	Fair	Bad	Good	Good except at gaps	May occur if layer is imperfect		Difficult to obtain perfect layer	Fragile
2-gap metals with sectional liners	Good	Good	Good	Good except at gaps in torus	None	Bad	Good	
2-gap metal with continuous liner	Good	Good	Bad	Good except at gaps in torus	None	Bad	Good	Consumes appreciable power
2-gap metal with segmental liner	Good	Good	None	Good except at gaps in torus	None	None	Fair	

duration, thermal evaporation and sputtering should not be serious if materials of low atomic number are used. In the more severe transient initial conditions, sputtering may limit the duration of the first stage of the discharge. Metals are superior to insulators in thermal properties and ease of fabrication, but tend to form unipolar arcs when exposed to plasma. Unipolar arcing arises from the potential difference between wall and plasma, whereas power arcing is due to the applied pulse and occurs at the torus gaps, of which there must be at least one to avoid short circuit of the electric field. Table I above lists various kinds of torus and summarises their qualities. Fig. 2 shows three possible liner systems. The segmental system is designed to minimise unipolar arcing and is based on the minimum area principle: if current is to enter and leave the metal, breakdown must necessarily occur at two points simultaneously, and the probability of double breakdown is clearly reduced by dividing up the area of metal exposed. The continuous liner in Zeta 1A is shown in Fig. 3. (Paper 2948, Choice of Materials and Problems of Design of Heavy Current Toroidal Discharge Tubes, A. E. Robson and R. Hancox.)

Vacuum System

The continuous liner system separates the discharge channel from the torus-liner interspace conferring the following advantages: (*a*) a pressure differential can be achieved between the two evacuated volumes, to reduce the probability of ionisation of gas in the torus main-gap region and inhibiting main-gap breakdown; (*b*) separate pumping of the interspace reduces atmospheric leaks into the discharge channel and contamination of the discharge; (*c*) the minimum of insulating material is used inside the main discharge tube, so removing a second source of discharge contamination; and (*d*) it is a simple matter to heat the liner, accelerating outgassing and thus improving the vacuum base pressure; joule heating can be employed either by direct connection to the liner or by induction, using the transformer core. In Zeta 1A, constructional difficulties have not allowed full advantage to be taken of the continuous liner system in respect of vacuum requirements. (Paper 2930, The Modification of Zeta in 1958, J. T. D. Mitchell *et al*,)

The pumping arrangements remained the same as in the Zeta 1A vacuum system, which consisted of a toroidal tube of 42 in bore by 11 ft mean diameter fabricated from 1 in aluminium plate with a 48 section insulated interleaved water-cooled liner made from $\frac{1}{8}$ in aluminium sheet. The torus was split vertically, each half torus being mounted on a trolley with its vacuum pumps and ancillaries, and arranged in such a way that the whole system could easily be withdrawn from the transformer core for servicing or modification. Experimental work in 1957 and 1958 was not seriously limited by vacuum techniques, since loss due to radiation from impurities in the discharge appears to have been only about 20 per cent of the energy input, but it is unlikely that a significant increase in temperature will be attained unless impurities in the discharge can be reduced by one or two orders of magnitude. (Paper 2904, Vacuum System Design, J. Blears.)

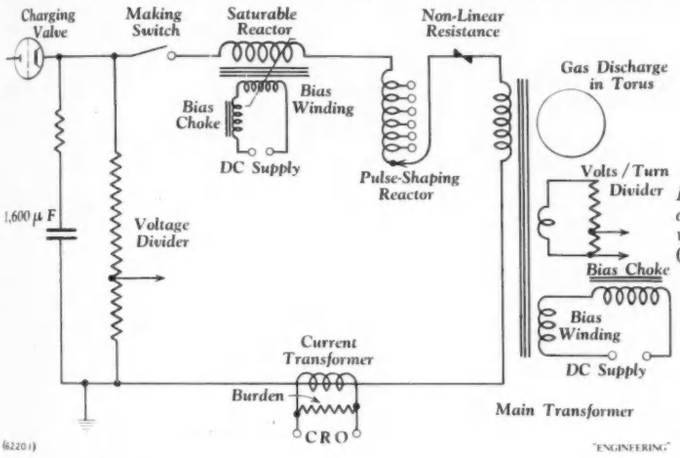
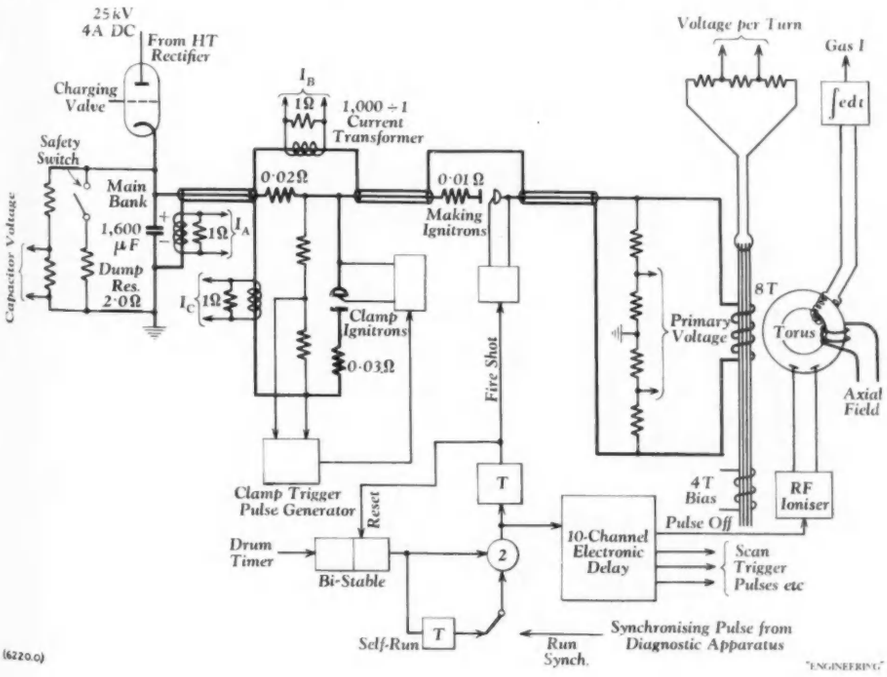


Fig. 4 The pulse circuit of Zeta 1A (below), with basic Zeta circuit (left) for comparison.



Switching

The modifications included changes in the circuit to increase rate of energy input to the discharge and improved control. In particular, experience with ignitrons on clamp-circuit duty suggested that they might be sufficiently reliable as series switches to replace the original making switch, a mechanical-switch—saturable-reactor combination. The clamp ignitron is required to hold off a reverse voltage of 25 kV and the making switch a forward voltage of 25 kV. The use of ignitrons in place of the switch-reactor combination removes from the firing-control circuit the variables due to the mechanical-switch operating-time jitter (about 1·5 millisec) and the saturable-reactor delay of 0·5 to 2·5 millisec (depending on applied voltage).

The pulse circuit of Zeta 1A is shown in Fig. 4, together with a sketch of the basic Zeta circuit. The resistors in series with the clamp ignitrons and the capacitors damp any oscillation if the clamp ignitrons break down in reverse. The damping resistance is divided between the series and clamp paths to reduce losses in normal operation and to limit the reverse voltage on the capacitor during clamping.

In spite of satisfactory operation into dummy loads, the making ignitrons proved to be unreliable when working into the main transformer; after a short period of operation above 15 kV, they sometimes failed to deionise during the 0·5 sec period between a discharge pulse and the start of condenser charging, thus short-circuiting the charging supply through the transformer primary. Investigation showed that this was due to the long decay of transformer magnetising current in the making and clamping ignitrons. As in Zeta, the core-bias current was not interrupted during the discharge pulse. The bias current is now reduced from 350 to 10 amperes prior to the main pulse, and the time-constant of the transformer-pulse magnetising-current decay has been reduced from 100-200 to less than 2 millisec because the core flux now reduces to the remnance point. It is reversed subsequently to the opposite remnance point by the bias supply. The reduction of available flux swing (about 10 per cent) is acceptable in the present circuit. With this sequence of circuit operation, the ignitrons carry current for less than 6 millisec and operate satisfactorily. (P2930.)

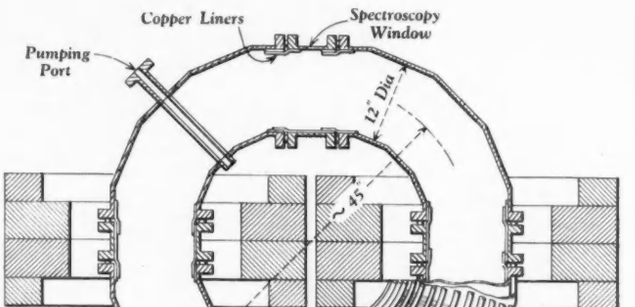


Fig. 5 Schematic diagram of Sceptre IIIA, a modified toroidal assembly at the AEI Research Laboratory.

Ignitrons

The ignitron, which employs a mercury cathode, is suitable as a switch in current pulsing circuits because of its ability to pass currents of high peak value, generally over 100 times its mean current rating, with low arc losses; moreover, the absence of continuous ionisation during the non-conducting periods enables it to withstand high voltages of either polarity. These features, together with the precise timing of the start of conduction, recommend the ignitron for use in capacitor discharge circuits, such as are used in thermonuclear research. (Paper 2947, The Ignitron as a Switch in High-Voltage Heavy-Current Pulsing Circuits, H. de B. Knight *et al.*)

Transformers

The problems which arise in designing transformers for experiments with gas discharges in toroidal tubes are rather unusual. The design of the transformer must be closely integrated with all the other items of the experimental installation. The size of the discharge tube is considerably influenced by the peak flux swing which the transformer will handle, and this in turn affects the amount of stored energy required. These factors together affect the circuit arrangement needed to achieve certain experimental requirements such as rate of current rise. Iron-cored transformers give the highest efficiency of energy transfer from an energy source in the primary circuit to the gas discharge which forms the single turn secondary circuit, and most pinched discharge experiments use iron-cored transformers. But it has been shown that under certain conditions an air-cored design is practicable and may offer experimental advantages by avoiding the obstruction which the iron introduces. Storage of energy in the transformer primary winding was shown to increase the energy-storage requirements considerably, but for certain experiments this disadvantage may be acceptable in order to obtain long decay times for the discharge current. It is possible to incorporate an inductive energy store in the transformer. In this case energy is transferred to the discharge by breaking the primary current of the transformer. The stored-energy requirements are much increased, but for some experiments there may be advantages to be gained which outweigh this drawback. The problem presented to the transformer engineer is unusual in that voltage does not appear as an initial parameter. In its simplest terms the problem is to establish a certain peak current in a secondary circuit, it being possible to specify a certain inductance per unit length of this circuit, in other words leakage inductance between primary and secondary circuits. Effectively the current is determined by inductance but the influence of resistance is considered. (Paper 2895, Transformer Designs for Toroidal discharge Systems, R. Carruthers.)

Sceptre IIIA: Modifications

The main structural details of Sceptre IIIA are shown in Fig. 5. The chief changes from Sceptre III are the following. First, the coils producing the stabilising magnetic field, $B\phi_0$, have been replaced by a new set of 208 single-turn water-cooled coils. Each coil is made from solid copper 1·5 in deep, the thickness being 0·25 in over the inner half of the coil and 0·5 in over the outer half (see Fig. 5), the coil thickness being varied in this manner to achieve minimum coil resistance with the space available. The coil is cooled by a $\frac{3}{16}$ in bore copper tube soldered to its outer edge. The coils are supplied from a 315 kW 3·5 kA d.c. generator. With these coils, not only can larger magnetic fields be obtained (up to 2·4 kG), but the improved cooling makes possible a higher discharge repetition rate. The magnetic field can be applied continuously up to 1·5 kG. Secondly, two of the straight sections in the torus have been replaced by new sections which are 2 in longer, that is 7·5 in long. As illustrated, one of these sections contains a quartz window situated close to the tube wall. With the aid of mirrors mounted outside the window, the discharge can now be viewed tangentially with respect to the circle of the torus as well as radially. The other section contains an aperture into which improved nuclear plate cameras can be fitted. In all other respects the apparatus is the same as Sceptre III. The primary has 24 turns, which can be connected to give an 8 : 1, 16 : 1 or 24 : 1 transformer ratio with respect to the discharge. The same condenser bank has been used so far, the maximum voltage being 30 kV, corresponding to a maximum energy of 66 kJ.

Comment

Speakers at the convention referred in particular to the energy loss discussed in Atomic Review last week. It was suggested on the basis of experiments with a small pinch apparatus at Los Alamos that the bulk of the losses arose from ultraviolet radiation due to impurities. Dr. A. A. Ware of the AEI Research Laboratory, who had suggested a mechanism of electron energy loss (reported last week), replied that in the small American apparatus the loss condition would be observed after the walls began to vaporise and impurities would necessarily be conspicuously present. Another speaker drew attention to a Russian Geneva paper which reported that magnetic *bremsstrahlung* energy loss was some 16 times that from ordinary *bremsstrahlung* a very important consideration at high temperatures.

It was also observed that scale and cleanliness were subjects that required detailed study and might be critical factors in thermonuclear reactor design. The first generation of thermonuclear reactors would, according to a speaker from AWRE, be based on the deuterium-tritium reaction, which Nature had generously given one of the highest cross-sections known. The neutrons emitted in this reaction were also fortunately of extremely high energy so that such reactors would be capable of breeding fresh tritium from lithium.

References to Thermonuclear Work

Previous references to thermonuclear work which have appeared in ENGINEERING are listed as follows.

Articles: Survey of fusion devices described at 1958 Geneva Conference (R. J. Bickerton) 26 Dec. '58 p. 824; Summary of work on pinch effect reported at 1958 Geneva Conference (A. A. Ware) 19 Dec. '58 p. 796; 1958 Geneva Conference fusion reactor summary (Sir John Cockcroft) 19 Sept.'58 p. 374; Fusion apparatus at 1958 Geneva Exhibitions 5 Sept. '58 p. 326; Fusion power prospect (A. Gibson) 23 May '58 p. 649; Catalysed fusion reactor (A. Ashmore) 4 April '58 p. 430; Thermonuclear reactors (I. V. Kurchatov) 4 April '58 p. 431; Plasma temperature discrepancies (A. E. Ruark) 4 April '58 p. 431; Small-scale thermonuclear apparatus and scale effect 7 Feb. '58 p. 184; Zeta—introduction, description and results 31 Jan. '58 p. 134; What the Zeta experiments mean (R. S. Pease) 31 Jan. '58 p. 134; Controlled thermonuclear reactions—background and introduction (A. A. Ware) 15 Nov. '57 p. 610; Neutron emission in high current gas discharges—work at AWRE (H. A. B. Bodin and J. A. Reynolds) 25 Oct. '57 p. 538; Gas discharge research in the Soviet Union (I. V. Kurchatov) 11 May '56 p. 322; Background to thermonuclear power 4 May '56 p. 318; Power from fusion (H. J. Bhabha) 19 Aug. '55 p. 235.

Atomic Review: BNEC Convention on Thermonuclear Processes —present state of theory, fundamental problems outstanding, electron energy loss, direct conversion 1 May '59; Electric field for thermonuclear containment, Thermonuclear course in France 1 May '59; Mirror machine studies at AWRE 20 March '59; Siting British thermonuclear research, Modifications to Zeta, Runaway ions discounted, Plasma heating mechanism, Enamelled torus 13 Feb. '59; Thermonuclear work in Germany 2 Jan. '59; Convention on Thermonuclear Processes announced 5 Dec. '58; Controlled fusion research at AWRE, Exchange of thermonuclear workers (US-UK), Zeta research continues, More about OGRA 31 Oct. '58; Manager for Winfrith 3 Oct. '58; Energy balance, Pinch effect, forms of magnetic insulation, Magnetic traps, Confinement time and field strength, Direct conversion, Fuels, Explosive fast discharges, Apha, plasma acceleration, plasma loop, high explosive and other Soviet approaches, Zeta promising (USSR view), Stellarator, Mirror machine, Direct current experiment, Shock waves for preheating, Homopolar generation of pinch field, Fusion move to Winfrith 26 Sept. '58; Geneva fusion summarised (including reference to energy-loss "crevasse") 12 Sept. '58; Thermonuclear research declassification 5 Sept. '58; UK, USA, USSR, France—thermonuclear research 29 Aug. '58; Euratom fusion, UK Geneva, papers 22 Aug. '58; Zeta 1A and 1B, Fusion by injection (DCX), French linear and toroidal thermonuclear apparatus 8 Aug. '58; Pictures of US thermonuclear apparatus (DCX hot ion injector, Stellarator, mirror machine, pinch machine), Power supply for Zeta, Tritium must be present for self-sustaining thermonuclear reaction (Denmark), Swedish apparatus 18 July '58; Smaller torus and neutron spectra (Zeta) 20 June '58; Fusion power prospect, Neutrons due to acceleration or instability in Zeta 23 May '58; Four paths to fusion (pinch, mirror and DCX, Stellarator 16 May '58; Catalysed or cold fusion, Soviet thermonuclear work, Temperature of Plasmas, Perhapsatron 4 April '58; British participation at Geneva, Structural insulation in Zeta, Homopolar generator for thermonuclear work proposed in Australia, Zeta booklet 14 March '58; Zeta dismantled, Zeta model, Soviet thermonuclear work 7 March '58; Induction heaters and neutron counters for Zeta 14 Feb. '58; Zeta modifications, Neutron emission, Anglo-American fusion conference, Implications of Zeta, Thermonuclear work in France and Sweden 7 Feb. '58; Neutrons in Zeta, Harwell team, Contractors for Zeta, Speculation on seawater, Glossary of thermonuclear terms 31 Jan. '58; Criteria for thermonuclear fusion, Neutron emission, AWRE work, Zeta, Energy balance, Power from seawater, Other thermonuclear fuels, Cold fusion at Liverpool, UKAEA fusionannounced 24 Jan. '58; Five million °C in Zeta, One million degrees C in USSR, Other approaches and the mu meson, Shock waves, Producing plasmas 10 Jan. '58; US-UK exchange information, Thermonuclear neutrons and 5 million °C in Zeta, Plasma instabilities, Lithium source, Helium 3 enrichment 27 Dec. '57; Cold fusion 13 Dec. '57; UK-US conference on thermonuclear research 8 Nov. '57; Fusion perspective, Neutron emission in gas discharges, Pinches in deuterium, Variation of neutron yield 25 Oct. '57; ConFusion 18 Oct. '57; Physical Society conference on plasma physics, High current plasmas at AWRE, Shock tubes at Harwell, Cold fusion 11 Oct. '57; Energy release from fusion, kinked tube 13 Sep. '57; Mesonic atoms 23 Aug. '57; Zeta instabilities, Stellarator, US private fusion, Transfer function for fusion reactor, Five cupfuls of petrol 2 Aug. '57; UK industrial fusion conference, Fusion research in US GEC, Useful energy content of seawater 5 July '57; Lithium institute 3 May '57; Gas discharge, Stellerator, Fusion probability, 26 April '57; Thermonuclear information exchange (UK-US) 15 Feb. '57; Cold and hot fusion, Physical Society papers, Thermonuclear criteria, Reaction rates, Pinched gas discharge 25 Jan. '57; Faraday Lecture and fusion at AEI Research Laboratory (T. E. Allibone) 18 Jan. '57; Flux for fusion cold fusion and the negative mu meson, Firms study fusion (AEI), Shock waves and whirlpools, Direct conversion, Containing tank for fusion, Fundamentals of fusion, American Nuclear Society conference 11 Jan. '57; Separating heavy water by crystallisation process 7 Sep. '56; UKAEA and controlled thermonuclear reactions 10 Aug. '56; Cyclic fusion processes involving lithium and carbon 27 July '56; Eclipse of fission? 1 June '56; Binding energy and the source of fusion power 25 May '56; Insulation, Containment, Explosions between heavy hydrogen gas and oxygen in USSR, Shock waves at Los Alamos 18 May '56.

Notes and News

Chapel Cross Opened

The Chapel Cross power and plutonium plant operated by the UKAEA was formally opened by Sir John Crabbe, O.B.E., M.C., T.D., H.M. Lord Lieutenant for Dumfriesshire, on 2 May. The station is substantially similar to the UKAEA's Calder Hall station, which was described in detail in ENGINEERING (vol. 182, pp. 418, 469, 502, 534 and 563, 1956).

Among the principal contractors for the Chapel Cross plant were: Babcock and Wilcox Limited, the Distillers Company Limited, the English Electric Company Limited, W. T. Henley's Telegraph Works Company Limited, James Kilpatrick and Sons Limited, the Metropolitan Vickers Electrical Company Limited, the Mitchell Construction Company Limited, C. A. Parsons and Company Limited, Stewarts and Lloyds Limited, Strachan and Henshaw Limited, Thos. W. Ward Limited, and Whessoe Limited.

British Nuclear Marine Firms

The Civil Lord's Committee on the Application of Nuclear Power to Marine Purposes at its meeting last Tuesday heard expositions by British firms of the reactor systems in which they are interested commercially. The firms concerned were: AEI-John Thompson Nuclear Energy Company Limited, Babcock and Wilcox Limited, London, de Havilland Engine Company, GEC-Simon-Carves Atomic Energy Group, Hawker Siddeley Nuclear Power Company Limited, Mitchell Engineering Limited and Fairfield Shipbuilding and Engineering Company Limited, and Vickers Nuclear Engineering (Rolls-Royce, Foster Wheeler, Vickers).

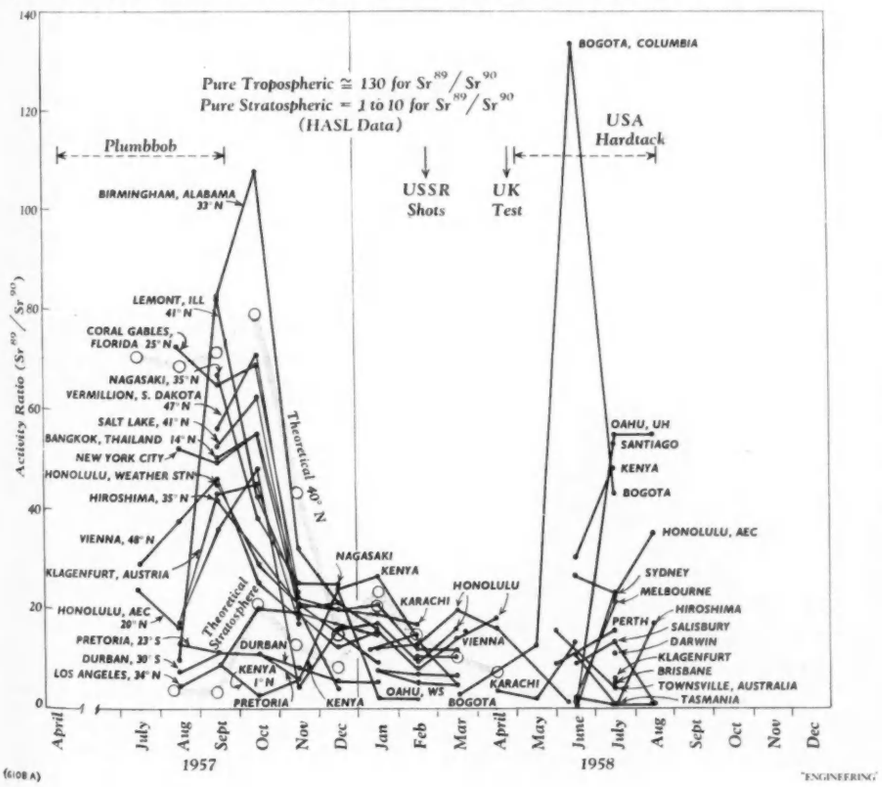
RADIOACTIVE FALLOUT

In answer to a question on radioactive fallout by Captain Pilkington (Conservative), the Prime Minister, Mr. Harold Macmillan, replied that even if deposition of the strontium 90 already injected into the stratosphere continued at the higher rate observed in the summer of 1958, the concentration of this substance in bone was unlikely to approach the level which the Medical Research Council advised in 1956 would require "immediate consideration." The Prime Minister said that he had for some time promised to produce a statement "not so long as to be almost unreadable for the ordinary person, not so technical as to be almost unintelligible, but sufficiently long to be an important contribution." Sections of the Prime Minister's statement are reproduced below. The illustration on this page, published by the United States Atomic Energy Commission, serves as a background to Mr. Macmillan's observations.

The debris in the stratosphere resulting from test explosions of nuclear weapons contains radioactive materials, of which strontium 90 merits the most immediate attention. . . . Measurements since May, 1958, have indicated a general rise, involving an approximate doubling of the rate of deposition in rainfall in the United Kingdom. The estimation of the fall-out likely to occur in the future depends, amongst other factors, on an assessment of the total amount of radioactivity in the "stratospheric reservoir." . . . The *Report of the United Nations Scientific Committee on the Effects of Atomic Radiation* contains the following observations on this subject: "Analysis of fallout material has shown that strontium 90 can remain in the stratosphere for many years before being deposited on the earth. The depletion mechanism of the stratospheric reservoir is not yet adequately known. It has been estimated from measurement of fallout rate and stratospheric content that the annual strontium 90 fallout is about 12 per cent of the stratospheric content. This annual fraction corresponds to a mean residence time of about eight years which is in agreement with a value of 10 plus or minus 5 years derived from unpublished data. The concept of a constant fractional removal per year of the stratospheric content is inconsistent with meteorological principle. However, nothing better can be offered at present. If the concept is to be used, a mean residence time of about five years appears to be the best value and a reasonable upper limit is about ten years. The latter value has been used in the calculations, ... since it tends to yield results on the pessimistic side."

It has recently been suggested, notably by the United States Department of Defence, on the basis of an interpretation of their measurements, that the residence time of radioactive materials in the stratosphere has been overestimated. If this were true, it would confirm that the estimates made by the United Nations Scientific Committee were unnecessarily pessimistic, since there would be less of this material at present in the stratosphere than they estimated. There is some evidence to suggest that debris may leave the stratosphere more quickly from explosions in high latitudes than from explosions nearer the Equator. A shorter residence time would mean that the radioactivity would have had less time to decay before the fallout was deposited; but strontium 90 decays so slowly that the difference would be very small. There would also be an increased amount of shorter-lived fission products in the fallout, but the increase in the dose to body tissues from these would also be relatively small. Once radioactive materials have left the stratosphere and entered the troposphere, the local rate of deposition depends very largely on rainfall. Heavy rain tends to produce enhanced fallout. This is certainly one of the factors responsible for the higher recorded measurements of fallout in the summer of 1958. However, in subsequent months in which the rainfall in the United Kingdom was more nearly normal, the data so far available indicate that the rate continued high. There is evidence from the nature of the radioactive material deposited that this is likely to have been due to recent tests, presumably those conducted in the Autumn by the USSR, the fallout from which possibly occurred more rapidly because they took place in high latitudes. The so-called "Argus" experiments conducted about the same time by the United States are understood to have been three low yield nuclear explosions at great heights; they therefore resulted in only a very small addition to the radioactivity already in the stratosphere.

The apparent age of fallout is measured by the ratio of strontium 89 to strontium 90 content, based on the half lives of these constituents. The graph, published by the United States Atomic Energy Commission, shows monthly values of this ratio at various places throughout the world, together with values predicted by theory for 40° N latitude and for pure stratospheric fallout. As distinct from stratospheric fallout, tropospheric debris, having a mean residence time of only one month, has a much higher Sr 89: Sr 90 ratio.



In Parliament

BRITISH SPACE PARTICIPATION

Much interest continues to be shown in Parliament in the desirability of Britain constructing a space satellite and last week further attention was drawn to the matter by various members of the House of Commons. Some members suggested that even if Britain did not build her own satellite, she should at least combine with other countries to that end.

Viscount Hinchingbrooke (Independent Conservative) said that there was an urgent requirement for a British space research project and asked the Minister of Supply what discussions had now taken place with member nations of the Commonwealth for the creation of a joint scientific and technical staff to promote this research and for the payment of appropriate financial contributions. He urged the minister to bear in mind that the problem of the number of British scientists seeking employment in this field in the United States was not likely to be solved if the Government's programme proved to be no more than the leasing of space in a United States satellite.

An estimate was asked for by Mr. Alan Green (Conservative) of the cost of a five-year programme for putting into space British satellites powered by a combination of Black Knight and Blue Streak missiles. Mr. Geoffrey de Freitas (Labour) urged that equipment being developed for the Royal Air Force should be used for scientific research. He felt that any project based on equipment developed for military purposes would be very cheap indeed.

Mr. Roy Mason (Labour) inquired whether the Royal Society had succeeded in proving that such scientific data was to be secured by launching a space satellite as would warrant a planned programme. He felt that consideration should be given to the setting up of a special scientific committee, working under the minister.

Cooperative Research

It was urged by Mr. Frank Beswick (Labour-Cooperative) that, in view of the technical possibilities, consideration should be given to the official proposal made by Russia for a space research project on an international basis.

Mr. David Price (Conservative) asked about costs, and pointed out that the cost of the parent missile would already have been met to a large extent by defence expenditure. Mr. Paul Williams (Independent Conservative) sought an assurance that, if there were a shortage of finance, support would be asked for first from Commonwealth countries, in preference to any outside country. Mr. Jo Grimond (Liberal) thought that the project offered an admirable opportunity for cooperation, not only within the Commonwealth, but also with other European countries.

Commenting on these various aspects of the problem, Mr. Aubrey Jones, the Minister of Supply, said that he must ask members to await the statement of the Government's policy, which, he hoped, would be announced shortly. In the meanwhile, however, cooperation by Britain with scientists of other countries, including the countries of the Commonwealth and Soviet Russia, was taking place on the International Committee on Space Research.

So far as the Royal Society was concerned, he had informally referred the question of a space research project to certain Fellows of the Society some time ago and they had reported that results of considerable scientific usefulness would be obtained from space research. As he had indicated previously, the problem concerning British scientists who sought employment in this field in the United States was a most important one and was receiving the Government's consideration. The Government had much in mind the scope which any space research programme would offer for cooperation within the Commonwealth.

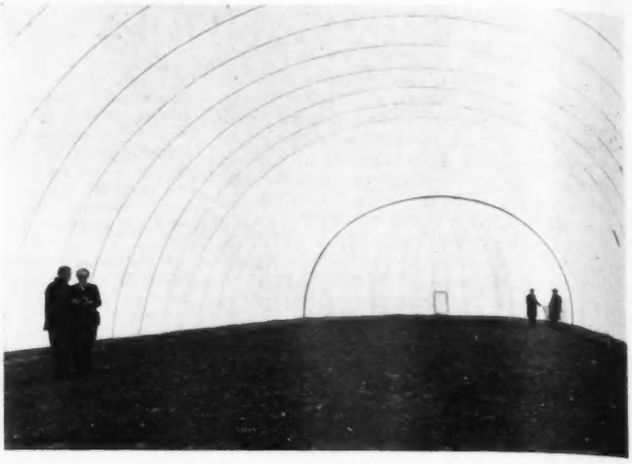
Still More Telephones

It was his department's intention, said Mr. Ernest Marples, the Postmaster-General, to connect about 370,000 new telephones this year.

CARRIED ON AIR

By taking advantage of the very lightweight synthetic fabrics now available that will remain inflated with only a slight air pressure for support, the Gourock Ropework Company of Port Glasgow have developed an " air-house " that requires neither poles nor guys to keep it erected. Modern materials have thus made practicable an idea put forward 50 years ago by Dr. F. W. Lanchester.

The skin consists of " PluViaC," a nylon or terylene fabric coated with a pvc paste, which is inflated and kept erect by blowing in air and maintaining an air pressure of about ½ in water gauge (0·02 lb per sq. in). Normal size doorways can be left open without impairing the performance of the structure and the cost of keeping a house 100 ft long by 40 ft wide and 20 ft high is said to be only 1*d* per hour, for running a 1 h.p. electric fan.



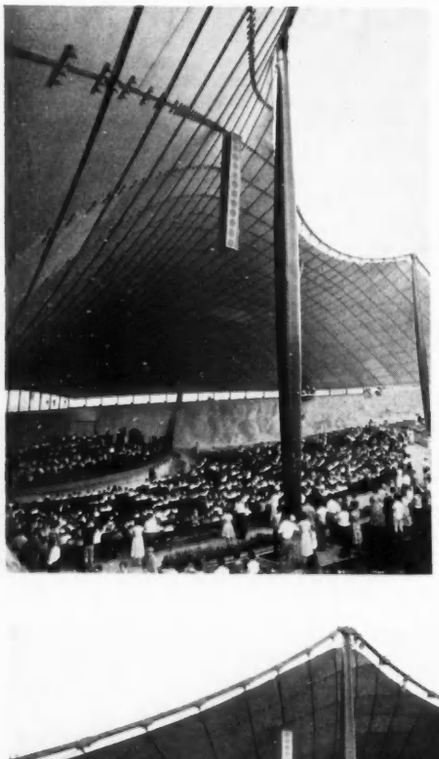
A low air pressure is all that keeps the Gourock air-house erect. Open doors are quite permissible.

To erect the house the deflated skin is laid out over the site, the sections laced together and the base ring secured either by ballasting with water or by pegging down. A large volume of low-pressure air (4 to 6 in w.g.) is then blown under the fabric. The fan is kept running as long as the house is in use, and if it is shut off the roof slowly falls over a period of about 10 to 15 minutes. (By reversing the fan, the house can be deflated even more quickly.)

The cloth used has a proofed weight of between 16 and 17 oz per sq. yd. The treatments available are claimed to render the fabric either capable of withstanding intensive sunlight and heat, as might be found in the tropics, or flexible at the low temperatures experienced in the Arctic. British Geon Limited have collaborated with Gourock Ropework in the development work and have supplied all the pvc used in treating the fabric which is mildew-proof and dimensionally stable; it can also be fire-proofed without damaging its other properties.

These houses have many possible applications where temporary protection from the weather is required—not the least important being a means of carrying out building and civil engineering " in the dry."

ONE ACRE OF PLYWOOOD AND ALUMINIUM SAIL



" Suspension architecture " is the structural feature of Melbourne's new music bowl. The flexible canopy covers almost an acre and is there to exclude extraneous noise from the amphitheatre. It is designed to float in high winds and comprises a wire-rope network overlaid with large sheets of waterproof plywood sandwiched between aluminium.

Architecturally, the bowl is one of Melbourne's most arresting structures. Its great canopy, sheathed with satin aluminium, is said to rise like a giant sail from the 10 acre park where it is located near to the centre of the city. The stage below is 110 ft across and 76 ft deep, providing space ample for the most spectacular theatrical and orchestral productions. " Echoless " amplifiers carry the music not only to the immediate audience of 22,000, but also to an area in which there is room for another 100,000—a not uncommon crowd for Melbourne's open-air recitals.

The two masts supporting the canopy are 70 ft high and of steel and glass fibre.

The canopy is supported by a wire cable 568 ft long, weighing 40 tons, which is anchored at each end 70 ft below ground and supported high across the centre by two steel and glass fibre masts 70 ft high and 140 ft apart. The wires forming the main support for the skin roof stretch 200 ft from the cable to be anchored beyond the back of the bowl. The tension in each wire is adjustable at the anchor point. A secondary rope system crosses the canopy from side to side and is " pegged " outside the bowl. The skin consists of ½ in plywood sheets covered on both sides by ½ in sheets of aluminium and the whole bolted to the rope system.

As already mentioned, the main purpose of the canopy is to act as a shield against outside noise; that it also forms a shelter for 2,000 people seated below it is described as being " purely a by-product " of the design.

The architect for the bowl was Mr. Barry Patten of the Melbourne firm of Yuncken, Freeman Brothers, Griffiths and Simpson.

Covered accomodation is provided for 2,000 people below the flexible canopy.

PRESTRESSED CONCRETE DEVELOPMENTS

A number of developments in the Lee-McCall system of prestressing concrete were announced recently. New plant has enabled the range to be extended to include a new 1¼ in diameter bar which has an initial load capacity of 55 tons. A 3½ in diameter duct will take four of these bars to provide a heavy-duty tendon able to provide a prestress of 220 tons. For this new bar, McCalls have also introduced a 60 ton stressing jack.

In place of the cut thread used previously on their bars, McCalls are now to put rolled threads with UNF form and pitch. This enables both the effective diameter and the permitted working stress to be increased. The new threads are also claimed to allow wider tolerances (± 2 in) on the length of the unit. Steel couplers, only a quarter of the weight of earlier standard and smaller in diameter, are available with the new threads. Modified wedge anchors and cast iron sleeve anchorages can now also be supplied. Further details may be had from McCalls Macalloy Limited, P O Box 41, Sheffield.

CLOSING FLOOD BANKS IN AN EMERGENCY

Closing major breaches in flood defences can be disastrous if wrong measures are applied. The further enlargement of the breach has to be prevented promptly and care taken to minimise scour both at the breach and along the line of the closure. The possible methods to be adopted were the subject of paper entitled " Emergency Measures for the Closing of Breaches in Flood Defences," given by Mr. Marshall Nixon, M.B.E., M.I.C.E., at the annual general meeting of the land drainage section of the Institution of Water Engineers last month.

The author began by reviewing the modes of breaching that are experienced in earthen floodbanks and instanced four main failures:—

(*a*) of the front face due to wave action or erosion;
(*b*) of the back face due to overspill;
(*c*) of the back face by slipping, due either to seepage at the heel or hydrostatic pressure in cracks in the crust of the bank; and
(*d*) of the foundations due to water in the substrata.

The development of the breach depends on amount of high-velocity water flowing through, and whether the flow is tidal and therefore continuously reversing in direction. In the worst cases the flooding water erodes the exposed ends of the bank, thus causing the breach to widen, and may also form a scour hole along the centre of the breach, possibly extending some distance inwards.

Small breaks where the water is either slow flowing or has become static can be sealed with a sandbag wall built in front and, if necessary, behind the line of the original bank. The author recommends not the Army sandbag (14 in by 33 in when flat) which is difficult to fill, but a wider bag, 18 in by 30 in, the mouth of which will receive a square-ended shovel. In an emergency all sacks are permissible, but if they are large and over-filled they can be difficult to place effectively.

For tackling a major breach the author lays down four stages:—

(1) prevention of further enlargement of the breach;
(2) reduction in the water velocity;
(3) sealing the breach; and
(4) strengthening the initial closure.

Although stage 1 must be put in hand on the strength of an initial reconnaissance, a detailed survey, and possibly model experiments, must follow before the optimum procedure for the following stages can be planned. The survey must determine the site conditions, access, shape and size of the scour hole, water velocity, tidal conditions, availability of materials, labour and plant, and the geology of the site. The provision of access for plant and material can form a major part of the operation.

In the remainder of the paper Mr. Nixon gives a number of case histories, describing in detail the methods used for closing large breaches that occurred in the United Kingdom during the 1947 fluvial flood, both here and in Holland during the 1953 tidal flood, and finally of work in China in remaking the broken banks of the Yellow River.

To prevent further erosion use has been made of sheet piling, deposited chalk, sandbags willow mattresses and even caissons of the Mulberry harbour type. Reducing the flow of water requires the gradual construction of breakwaters which can be ultimately sealed. Dumped stone, chalk and steelworks slag have all been used, frequently with lines of piles to give stability to the temporary bank, and, in the worst cases, placing a ring dyke of caissons.

It is, however, of great importance that the effect of proposed remedial measures shall be calculated—in particular that they shall cause neither secondary breaches elsewhere or increase the rate of scour, so precipitating further damage. To illustrate the magnitude of works that might be involved in closing a fully developed tidal breach, Mr. Nixon reported that, at Ouwerkerk in Holland in 1953, 2,000 men as well as much plant were employed for several months.

During the ensuing discussion speakers referred to action to be taken over incipient breaches. If tackled quickly enough it was often possible to prevent the development of a complete failure in the flood defences. Excessive seepage could be dealt with by sealing the front of the bank either with clay or tarpaulin sheets; a blanket of coarse aggregate over weep holes also eliminated seepage. Over-topping could be prevented by erecting a lightweight bank on top of the existing defences.

One speaker made the point that much effort could be wasted in attempting to close breaches where velocities were very high—it was possibly better to wait until the flow rate had fallen. Another drew attention to the efficacy of straw—even complete haystacks—for cutting down the velocity of water coming through the breach. (Suitable means of retaining the straw—and other dumped materials—are required; fishing nets, roped sacks and driven stakes are all possibilities for breaches of limited size.)

Finally, it was asked whether river boards had ready prepared flood organisation schemes and what methods they used for ensuring that their chief engineers had early knowledge of any breach.

Largest Power Station in Britain

The CEGB are now able to go ahead with their plans to build at Drakelow the largest power station yet projected in the United Kingdom. Drakelow A (240 MW) was commissioned in 1954 and the second station, B (480 MW), is now being built. The new station, Drakelow C, is to have an output of 1,500 MW.

The steam conditions, boiler size and generating units have yet to be determined. Such has been the increase in output per unit volume for power plant over the last few years that, although it will be the biggest station electrically, the civil work will not increase proportionately.

£1 million Pipeline in United Kingdom

Work has just begun on laying four underground pipelines, costing £1 million, to connect the Shell refinery at Stanlow, Cheshire, and Shell Chemical's works at Carrington, near Manchester. In addition two pipes will also be laid for Shell-Mex and BP Limited. The Shell Chemical lines will transport feedstock, intermediates and finished products. Completion is expected by late 1959. Also just begun is the work on the distribution centre for Shell-Mex at Partington, 10 miles south-west of Manchester.

The pipes will be in continuous operation and elaborate precautions have been taken to prevent corrosion. They are to be bitumen coated and will have cathodic protection. All welds are to be X-rayed. After commissioning, linewalkers will inspect the route every day. The minimum depth of earth over the pipes will be 2 ft 6 in and all efforts will be made to restore the ground to its normal use, which is mainly agriculture. The contractors are Arthur Monk and Company Limited, Warrington.

Ground Movement Near Trees

Trees growing in clay soils can cause severe settlement in buildings and damage to roads and pavements. To study the problem the soil mechanics section of the Division of Building Research, National Research Council, Canada, have carried through a programme of measuring ground movements near to elm trees 45 to 60 ft high planted in clay. It was found that in cool wet summers, vertical movement ranged between ½ in and 1½ in at the surface 5 ft from the trees. In dry summers, these movements were tripled and measurements of 1½ in were recorded as much as 20 ft from the trees. It was shown that stability could be maintained by keeping up the water content of the clay by watering.

For shallow footings the Canadians found the recommendation of the British Building Research Station—" tree planting distance should be the height of the mature tree "—satisfactory. Where space is limited the Canadians found that trees could be planted closer to the structure than this if the foundations were deeper.

Standardisation in Building

A special meeting on standardisation in building, arranged by the Economic Commission for Europe, is to be held in the Palais des Nations in Geneva on the 17 and 18 June. One objective will be to see what effect standardisation has had to date on the cost of house building and on international trade in building materials and components. It is hoped by the Housing Committee of ECE that the Geneva meeting will be attended by not only official delegates, but also by representatives from manufacturers of building materials and from contractors.

Code of Practice on Tile and Slab Flooring

All the work involved in the laying of clay or concrete tile flooring, and brick, natural or cast-stone flooring bedded on a solid base is dealt with in a revised code of practice issued by the British Standards Institution. The title of the 19 page publication (CP.202: 1959) is *Tile Flooring and Slab Flooring*; copies can be obtained from the Institution, Sales Branch, 2 Park Street, London, W1 (5*s* 0*d* plus postage).

Prefab Stations for LM Region

British Railways (London Midland Region) have a system for prefabricating small and intermediate sized stations. Tenders based on the system have been invited in connection with the reconstruction of several stations on the electrified Manchester-Crewe line.

The system, which is based on a 40 in module, consists of four main elements: an aluminium structural frame, roof units, external wall panels and internal partitioning. The structural frame is built from cruciform-section columns and rectangular beams which are pin jointed. Sufficient rigidity is available in the jointing to allow the frame to stand during erection, but the bracing obtained from the wall panels is essential to the design. Two roof forms have been designed, with either cantilevered awnings or infill. The former uses stressed skin plywood box beams of triangular section which project along the line of the soffit beams. The infill unit rests within the depth of the aluminium beams and is made of simple hollow stressed-skin punts of plywood. For the wall panels, the outside skin is of coloured reinforced polyester resin sheet; the reinforcement is of glass fibre with the addition of expanded metal where this is necessary; the lining is building boards.

It is expected that this station form will be used for reconstruction work along the Manchester-London route when electrified.

Twin-Main Boring in Road Improvement Scheme

To permit construction of the underpass from Knightsbridge to Piccadilly, part of the Hyde Park road improvement scheme, a 21 in gas main and a 15 in water main are being diverted. The work is being done by William Press and Son Limited, London, SW1, who are boring under the East Carriage Drive to save the consequences of an open cut, road reinstatement and related traffic disruption. Sleeves rolled from ¾ in plate will be used to line the bores, which are 161 ft long. The sleeves, auger and cutting head were all made by the fabricating division of the contractors.

THE TEN-PLUS BRAKE METER

Changes in Motion Registered on Multipurpose Dial

One of the requirements of the forthcoming "ten-plus" examination for motor vehicles is that all testing stations must possess portable brake testing equipment, regardless of whether they are already using a stationary-type tester. To meet this demand, a new version of the Bowmonk Dynometer Mk. III has been designed and is now being marketed jointly by Bowser, Monks and Whitehouse Limited, Doncaster, and Small and Parkes Limited, Manchester. Known as the Don Brake Meter Mk. III, it has been fully approved by the Ministry of Transport and Civil Aviation for use in the Vehicle Testing Scheme.

Although brake testing is said to be the primary function of this instrument, its range of use goes far beyond that. In fact to the ordinary motorist its other main function, as an accelerometer, is of even greater practical value. It will indicate acceleration performance in the same way as it shows deceleration (braking) and, by regularly recording such figures, the motorist can obtain useful information in relation to the overall performance of his car. An ENGINEERING staff writer, who drives a small convertible, recently made good use of the Don Brake Meter to tune his engine for optimum acceleration. He also checked the potency of some of the various makes and grades of petrol that are available. In this he found no difference between the well known brands but quite an appreciable difference between the three grades.

By keeping an accurate and regular check on acceleration, a motorist can detect any minor changes that occur due to engine wear, carbonisation, or misalignment of components, and act accordingly. Similarly, by watching the deceleration figure from time to time he can make sure that his brakes are always in good working order. This is particularly important since deterioration of brake performance is nearly always very gradual and can escape detection until it has passed the danger level.

The free-running test is another useful facet of this versatile instrument. By running a vehicle in neutral on a level road, at about 20 m.p.h., it is possible to detect even the smallest amount of drag on the free-running performance. Drag occurs more often than is commonly realised but is generally not fierce enough to be detectable without some kind of instrument. It may be caused by rubbing brakes, excessive toe-in of front wheels, dragging clutch, low pressure tyres, or faulty wheel bearings. It is obviously an advantage to be able to detect any of these faults as soon as they arise.

Since this meter is sensitive to gradient, in the fore and aft direction, it can be used to obtain the value of the car's gradient at any instant. The actual value of the gradient is given on the dial as a percentage; a reading of 25 per cent indicates a gradient of 1 : 4.

The model shown in the illustration has a base mounting and is intended for use at test stations where it can be moved easily from one vehicle to another. For the private motorist another type of mounting is supplied so that the meter can be permanently attached to the dashboard. This model also has a removable suction pad which can be used for a simple, semi-permanent mounting on the dashboard or windscreen.

The Don Brake Meter obtains its rate of change readings by the translation of the movement of a known weight (pendulum) through a controlled arc, the movement of the main indicator needle being obtained through a precision gear train. An "idle" needle is moved into position by the main needle, where it records the maximum dial reading; it is then zeroed manually by turning a knob in the centre of the dial, ready for the next reading.

Being a pendulum operated mechanism, it is subject to critical damping in order to obtain correct readings of percentage "g" at both ends of the scale. Normally this would be achieved by using a Viscostatic oil damping medium, sealed into a separate inner casing. However, since even the best of these oils does not have a sufficiently static viscosity over the range of temperatures that may be encountered, a new medium has been chosen for the Don Meter. It consists of a special blend of silicone fluids which has been shown to have exceptional constancy of viscosity.

All the working parts of the meter are immersed in a high grade lubricant, which suggests that the wear, even over several years, will be negligible. But in spite of this the calibration may need adjustment from time to time. To facilitate this the manufacturers have set up a scheme for rechecking, under laboratory conditions, at a nominal charge. The vehicle test station meters will be checked annually under this scheme.

On an initial cost basis (£12 12*s* 0*d* retail), the Don Brake Meter appears to be of sound value to any garage man likely to be involved with the forthcoming ten year old vehicle tests. For the private motorist twelve guineas seems a lot. But then there are many more reckless ways of spending that kind of money than on a precision instrument which combines the functions of accelerometer, drag indicator, gradient inclinometer and brake tester.

FARINA-BODIED RILEY

By Gordon Wilkins

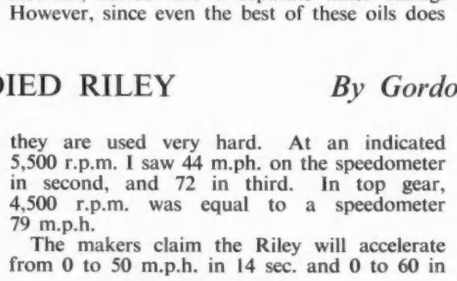
With the introduction of the Riley 4/68 every dealer handling British-built BMC makes can offer a 1½ litre car with five-seater body styled by Farina. This model, latest and reputedly last of the series, has a small air intake and lozenge-shaped badge faintly reminiscent of the traditional Riley radiator grille, but no other mechanical or style feature to connect it with Rileys of the pre-BMC era.

It is in fact identical with the MG Magnette recently announced except for the frontal appearance and some details of trim and equipment (it has a tachometer, which the MG has not). It has the same rear fins as the MG (which are shorter than those on the Austin A55, Morris Oxford and Wolseley 15/60) and it has the same twin-carburettor version of the 1,489 cc engine giving an installed 66·5 b.h.p. at 5,200 r.p.m. with maximum torque of 85 lb-ft at 3,300 r.p.m. The carburettors are the SU diaphragm type, 1½ in diameter. Axle ratio is 4·3 to 1, giving 16·53 m.p.h. at 1,000 r.p.m. in top gear, with tyres of 5·90—14 in.

In a brief road trial I found it a lively comfortable car which promised untiring distance motoring at interesting average speeds. The short central gear shift works very smoothly and the pedals are comfortably arranged, but the accelerator does not lend itself to easy heel and toe operation.

Steering is light and accurate and the car handles well although it is not entirely free from roll. The brakes seem well up to their job but there is a tendency to lock the rear wheels if they are used very hard. At an indicated 5,500 r.p.m. I saw 44 m.ph. on the speedometer in second, and 72 in third. In top gear, 4,500 r.p.m. was equal to a speedometer 79 m.p.h.

The makers claim the Riley will accelerate from 0 to 50 m.p.h. in 14 sec. and 0 to 60 in



17·7. Maximum speed is quoted as 85 m.p.h. Despite its lively performance, economy is well maintained according to the works claims, which give steady speed fuel consumptions as follows: 30 m.p.h. 37·9 miles per gal; 40 m.p.h. 38·8 m.p.g.; 50 m.p.h. 33·5 m.p.g.; 60 m.p.h. 29·4 m.p.g.; 70 m.p.h. 25·1 m.p.g.

One cylindrical air cleaner is connected to a cast aluminium alloy elbow supplying the two semi-downdraught carburettors. The exhaust manifold is a single iron casting with two hot spots bolted to the alloy inlet manifold. The tachometer is driven from the rear end of the camshaft.

The interior is pleasantly finished in leather, with comfortable separate front seats and carpet floor coverings. Instrument panel and door rails are in walnut, the instruments being grouped under a cowl in front of the driver. The speedometer, reading up to 110 m.p.h., has trip and total recorders; the tachometer has a yellow sector beginning at 5,000 r.p.m. and a red sector from 5,500 to 6,000. In between are fuel gauge, ammeter, oil pressure gauge and thermometer. In the centre of the panel is a clock.

Equipment includes screen washer, heater and demister, four ashtrays and armrests on the rear doors, and two roof lamps. Twin windtone horns are controlled by a half horn ring. Like other models in this series it has the roomy 19 cu. ft trunk, with spare wheel in a separate anti-theft compartment underneath. The non-slam zero-torque door-locks, with child-proof safety catches, cannot be reached when the doors are closed. Stainless steel window frames are fitted. The glove box is lockable and there are parcel shelves at front and rear. The car is guaranteed for twelve months.

Safety features include matt-black padded top to instrument panel, dished steering wheel, soft edge to parcel shelf, recessed instrument group, and clear all-round vision. The warning lamp in the end of the trigger operating the indicators is automatically dimmed at night to avoid distracting the driver, and equipment includes a reversing lamp. Duo-tone body colours, radio and many other approved accessories are available at extra cost. Basic price is £725, plus £303 4*s* 2*d* tax.

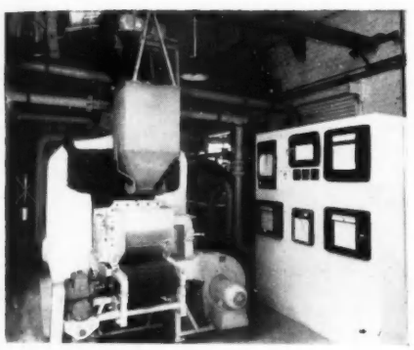
TWENTY-ONE YEARS OF COAL RESEARCH

BCURA Comes of Age

During the 21 years of its existence, the British Coal Utilisation Research Association have contributed a great deal towards the better use of coal and its derivatives in both industry and the home. When speaking at the 21st anniversary celebration luncheon at BCURA's headquarters on 22 April, Lord Mills, Minister of Power, commented on the significance of their work and on the many changes of the fuel situation in this country since the conception of BCURA. In a well delivered speech the Minister acquainted his audience with some of the past achievements of the association and went on to discuss some of the " burning " topics of today's fuel situation.

The Minister pointed out that, for the first time in 20 years, the coal industry is operating in a buyers market. " Coal is now in competition with fuels which have considerable attraction for the consumer in price, cleanliness and ease of handling . . . there is constant pressure on the coal consumer to turn to fuels that are easily handled, that are free from dirt and on which they can depend for a regular and high quality supply."

Although the richest of our natural resources, coal is now facing a potential period of comparitive depression, brought about by fierce competition from oil, gas and electricity and, to some extent, by the new demands for a reduction of air pollution. This may appear to be a gloomy outlook. However, to the research workers at BCURA it serves only as a renewed challenge to their skill in making the most of this important indigenous raw material and, judging by their recent work, the challenge is being well met.



Fully automatic stoker for central heating in large buildings.

Current research at BCURA is being directed mainly toward improving and devising appliances suitable for burning small coal; developing methods for the automatic control of combustion; reducing atmospheric pollution from coal burning appliances; and developing new products from coal.

DOMESTIC

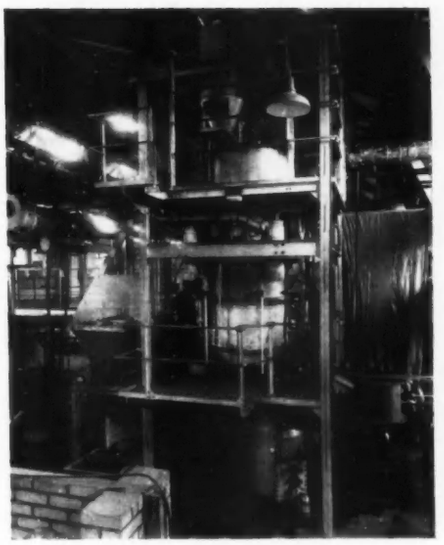
The small-pipe, forced circulation, central heating system which was developed by the Domestic Appliance Laboratories of the association not so long ago, has evoked considerable public interest. Continuing in this field of development, the same laboratories have now demonstrated a method of automatic control for a miniature chain-grate stoker which can be used to fire central heating boilers for offices or blocks of flats. It permits half inch coal to be burnt smokelessly at high efficiency over a wide range of heating loads and is sufficiently automatic to need no more attention than can be provided by one or two visits from an unskilled man each day. These factors make it fully competitive with any oil burning system.

As a first step toward reducing air pollution from coal burning appliances, the association's laboratories have developed a number of scientific methods for the measurement of dust and grit emission from boiler furnaces. The automatic particle sizing apparatus which they have devised can now be employed on particles down to two microns and can be used to carry out up to eight analyses per day. On the domestic side, the mode of release of sulphur from a typical house coal is being studied in detail, using an open fire installation with induced draught. So far analytical measurements have shown that surprisingly large amounts of hydrogen sulphide can be evolved, particularly after refuelling. The amount produced varies greatly and is dependent upon several factors, notably the state of the fuel bed, the burning rate, and the coal size. Further work is in progress to determine the conditions required for the minimum and maximum contributions of hydrogen sulphide.

INDUSTRIAL

One of the most concentrated efforts now being made at BCURA is in connection with the development of a cheap method of converting small coal into gas, and ultimately into oil. Future large-scale processes for completely gasifying low-grade coal to produce synthesis and fuel gas are likely to be operated under pressure and at temperatures high enough to slag the ash from most British coals. Research is being carried out, under contract with the Ministry of Power, to study the problems that such processes involve. The scope of the investigations covers the study of means of introducing low-grade fuel of size less than $\frac{1}{8}$ in into a pressurised system; investigating the problem of cleaning and purifying the make-gas; the reliable removal of slag, its quenching and depressurising; and the design of more efficient means for bringing together solid and gaseous reactants. The association's experimental slagging gasifier at present consumes about a ton of fuel per hour and can take, in short tests, up to half this in the form of pulverised coal. It has been operated successfully at various ash levels and over a range of ash fluidities. Background studies have made possible the tentative correlation of slag viscosity-temperature curves with slag composition; and methods of analysis have enabled the important constituents of ash to be determined at the rate of four samples per day.

Automatic particle counter and sizer works down to 2 microns.



Experimental fixed-bed slagging gasifier, built under contract with the Ministry of Power.

A large number of industrial and domestic heating investigations, which have made substantial progress during the past year, are mentioned in the 21st annual research report issued by the council of BCURA. One investigation has shown that the operation of a power station boiler with less than one per cent oxygen in the flue gas is quite feasible and leads to a large decrease in the sulphur trioxide concentration (and hence a decrease of dewpoint). It has also been shown that catalysis of sulphur trioxide formation by metal surfaces at high temperatures can be important. Studies of tar decomposition in producer-gas-fired furnaces have suggested that regenerator temperatures could be raised without substantially lowering the quality of the gas.

BASIC

Basic researches have included further studies of the formation (or release), and subsequent thermal decomposition, of the plasticising material in heated coking coals and in other coals following mild treatment with hydrogen. Research work on pile graphite, undertaken for the United Kingdom Atomic Energy Authority, has shown that closed pores become accessible during the reaction of the graphite with oxidising gases, and an estimate of the importance of internal burning has been obtained. Work on the production of chlorofluorocarbons from low-rank coal, which has received wide industrial interest, is still continuing. The latest fluorine efficiency figure obtained is 30 per cent.

Only a part of the current research and development programme of this association has been mentioned here. However, it is sufficient to make it apparent that BCURA are doing an important job. They are largely responsible for reducing, or eliminating, the unfavourable gaps that have arisen between coal and its rivals and, since coal is Britain's only major source of mineral wealth, this work can be considered to be of national importance.

MEASURING GEAR TEETH ERRORS UNDER LOAD

By B. WOOD, B.Sc., G.I.Mech.E.

Department of Mechanical Engineering, University of Leeds

PRESENT methods of inspecting a gearwheel, measure whether the wheel is within specified dimensional limits. Such limits are laid down from experience, and concern eccentricity, tooth spacing, and tooth profile. The manufacturing errors are measured in various ways, from the simple roller and micrometer to elaborate instruments capable of rapid and simultaneous measurement of several dimensions. Another rapid method of inspection is to compare the gearwheel with a master gear. This is done by rolling the gear and master together, on a variable centre machine, the change in centre distance being a measure of the errors. A disadvantage of this method is that both flanks of the teeth are in contact and therefore effect the measured error, whereas in use only one flank is in contact.

From the inspection measurements, however, little can be determined about the behaviour of the gears when running together under load, at their correct working centres. A knowledge of the behaviour is particularly important for heavily loaded precision gears, where the manufacturing errors are small and the elastic deformations of the teeth due to load are of equal or greater magnitude. It is these errors which can cause dynamic loading of the meshing gears, as discussed by Johnson.[1] The method described in this paper has been devised to enable the errors of a pair of loaded gears to be measured.

The gear teeth errors to be measured for a pair of spur gears are defined as the deviation from uniform rotation of one gear when the other gear is rotated uniformly. This is done with the gears running slowly together under load, at their correct working centre distance. The errors are composed of the manufacturing inaccuracies and also the elastic deformations due to load, these being deflection and flattening of teeth, and effects of tooth modification if any, when not running at the design load.

Harris[2] used a basically similar method to the one described below; he measured the difference in movement of two tapes as they unwound from discs concentric with the test gears. The disadvantage of this method was that the error curves had to be plotted point by point, with the gears stationary in successive angular positions.

The apparatus described below was designed to give continuous recording over at least one revolution, with the gears rotating at slow speed to avoid any dynamical effects. The method had to be sensitive and robust, the gear teeth errors being of the order of 0·0002 in.

The device was used on a pair of spur gears, 1 : 1 ratio, 3 in pcd, diametral pitch 12. The gears form part of a power circulating rig, by means of which various loads can be applied to the test gears.

APPARATUS

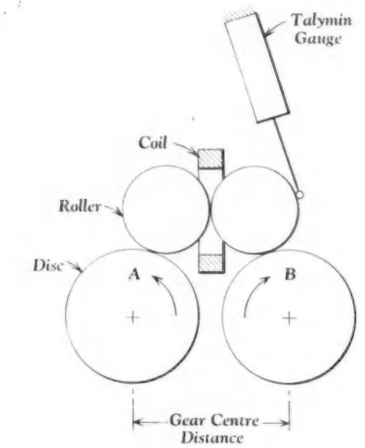
The measuring apparatus consisted of two $2\frac{5}{8}$ in diameter steel discs and two $1\frac{3}{4}$ in diameter steel rollers, hardened and ground. The discs were mounted concentric with, and rigidly attached to, the test gears. The two rollers were supported by the discs as shown in the drawing.

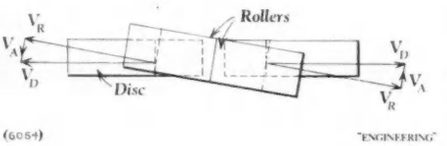
A coil of 250 ampere-turns was placed round the rollers as shown. The coil provided a method of preventing slipping between the rollers and disc, by exerting a magnetic pull between them. The remainder of the magnetic flux path consisted of the gear teeth and bearings.

The translational motion of the rollers was measured by a Talymin side-acting gauge mounted as in the drawing.

If both discs rotate uniformly in opposite directions then the rollers rotate about their own axis and they have no translational motion. The errors in the gears produce a deviation from uniform rotation of one of the discs when the other is rotated uniformly. This is equivalent to one of the gears being stationary, with the other gear having an oscillatory angular motion. The angular motion causes a translation motion of the rollers which is proportional to the errors. The Talymin gauge only picks up the effect of the gear errors, the rotation of the gears without errors is not recorded.

In the initial design the prevention of slipping by using a coil was not considered. Therefore





(6084) "ENGINEERING"

to give a reasonable load at the contact lines the rollers were made wider and smaller than the discs. The smaller diameter of the rollers decreased the sensitivity of the apparatus, the sensitivity depending on the sizes of both the disc and rollers. If the system had been designed initially with the coil to prevent slip, then the rollers could have been made the same diameter as the discs, resulting in an increase in sensitivity.

PRACTICAL DIFFICULTIES

(*a*) *Skewing of the Rollers.*—In practice it was found that for clockwise direction of rotation of disc A (see drawing), the rollers skewed on the discs, and for the opposite direction pulled into line with the discs. The rollers did not move relative to each other but skewed on the discs as a unit.

It can be shown as follows, that if the rollers are initially slightly skewed, then the skew will increase for one direction of rotation. Consider the rollers skewed on the discs, and the discs rotating with velocity V_D, at the point of contact with the rollers. If no slipping occurs the rollers will have two components of velocity at the points of contact, the sum of which will equal V_D. The components are a rolling velocity V_R about the roller axis, and a velocity V_A parallel to the axis of the roller, this being the skewing velocity. For anti-clockwise rotation of disc A, the skewing velocity decreases the angle of skew and for clockwise rotation increases the angle of skew.

The skewing of the rollers introduced a limitation in the use of the apparatus, and only one direction of rotation was possible.

(*b*) *Dimensional Errors.*—The gear teeth errors were small, approximately 0·0002 in. Therefore any dimensional errors of the discs and rollers were recorded by the Talymin gauge, and can be very much greater than the teeth errors. The dimensional errors which gave the largest readings were eccentricity of the discs, and a difference in disc diameters.

The eccentricity of the discs, with respect to the gear shaft, produced a sinusoidal wave once per revolution of the gears. Any eccentricity of the gears and bearings would produce a similar signal, and if these were to be measured the eccentricity of the discs would have to be made small. In the investigations for which the device was designed, the gear eccentricity was not required, therefore rather than trying to eliminate the dimensional errors at their source it was only necessary to eliminate the error from the gauge signal. Electrical filtering of the signal was considered, but because of the low frequencies was found to be impossible. The eccentric signal was cancelled by means of a signal at gear rotation frequency, obtained from a capacity gauge, one plate of which was an eccentric drum mounted on one of the gear shafts.

The difference in disc diameters produced a steady movement in one direction of the rollers. Care was taken in manufacturing the discs to make this as small as possible, and the movement obtained was about the same order as the teeth errors. The elimination of this steady movement was not possible, but as the magnitude was small, and the effect was easily distinguishable from the gear errors, its presence could be allowed for.

The ellipticallity and lobing of the rollers and discs provided other sources of error, but as care was taken to produce as near circular discs and rollers as possible, these were small. Fortunately, the dimensional errors produced low harmonics of gear rotation, while gear tooth meshing frequency was 36 times gear rotation. It was easy therefore to distinguish the tooth errors from the dimensional errors.

Dirt between the rolling surfaces showed as peaks on the error curves and care had to be taken to thoroughly clean and degrease the components before use.

(*c*) *Stick-Slip Effect.*—This difficulty arose not in the measuring device but in the power circulating rig used to load the gears. A jerky motion of the drive was experienced which tended to make the rollers slip, but did not otherwise invalidate the error measurements because both teeth remained in contact. The motion was a stick-slip effect at the gear teeth, due to the slow speed of the drive. The effect was reduced by increasing the torsional stiffness in the rig by putting in stiffer shafts, and by replacing flexible couplings in the driving system by rigid couplings.

While the measuring device was used on a 1:1 ratio gear pair, it could doubtless be used on other ratios. Also if single gear testing was required one of the gears could be a master.

Acknowledgement.—The author thanks the Mechanical Engineering Department, Leeds University, where the research was carried out.

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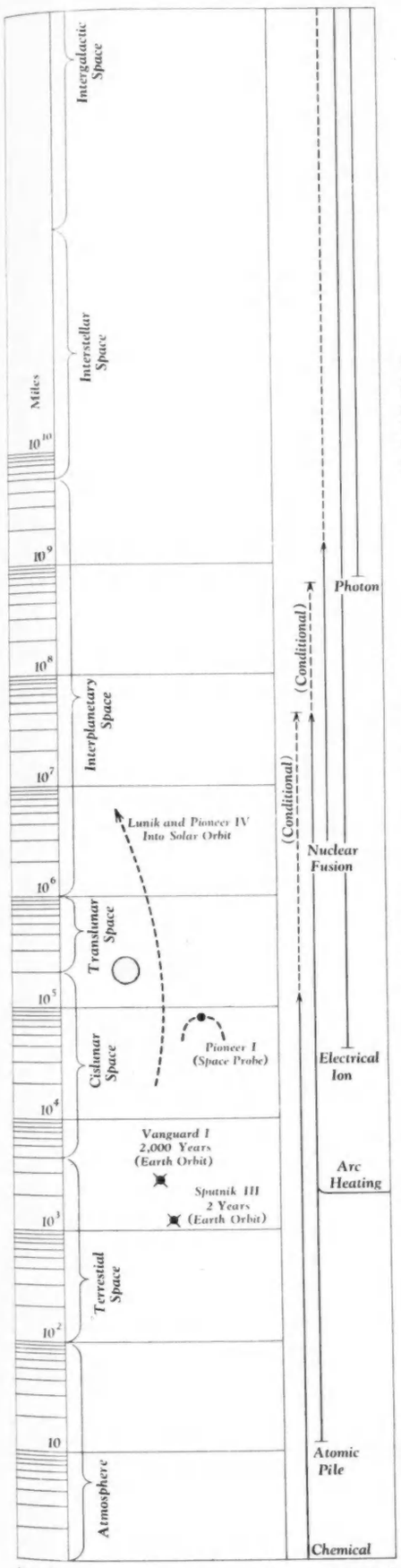
SPACE PROBES AND SATELLITES

A Summary of Progress

The recent statement in the House of Commons that Britain is to consider the question of attempting a space research project, using earth satellites, has evoked wide interest. The British missile programme is now technically ready to provide an initial launcher for an earth satellite; but the question still remains whether the additional expense of producing the satellites and their instruments is worthwhile. This question is now to be considered in the light of possible cooperation with other Commonwealth countries and, perhaps, the USA. A decision is expected before the end of August, when both the Commonwealth Space-Flight Symposium and the tenth Congress of the International Astronautical Federation are to be held in London. To refresh our memories on the achievements in this field, the following summary lists the main details of all the known satellite and outer space launchings so far.



USA

By far the largest number of known launching attempts and successes have been made by the USA. Since January, 1958, they have made 21 launchings and their successes include eight satellites, four lunar probes and one outer-space probe. The main details of these projects are as follow:

EXPLORER I. Satellite

Launched 31 Jan, 1958, at 33·5° N.

Altitude: Apogee 1,587 miles, Perigee 217 miles.
Period of Rotation: 115 minutes (approx.).
Weight and Dimensions: cylinder shaped satellite 6 in dia. and 80 in long, including the last stage rocket. Satellite weight, 30·8 lb; total instrument weight, 10·63 lb.
Lifetime: 3 to 5 years.

The instruments included those for cosmic ray count, temperature, meteorite density and two transmitters (one 10 mW and one 60 mW).

The launching vehicle was a four stage Jupiter C with an overall length of 70 ft and a weight of 64,000 lb:

Stage 1: Redstone missile, modified to burn hydrazine-based compound with an 83,000 lb thrust.

Stages 2, 3 and 4: Cluster of 11 solid propellant rockets surrounding a cluster of three or four rockets, surrounding single rocket final stage.

VANGUARD. Satellite (Attempt)

Launched 5 Feb., 1958.

The satellite was a 6 in dia. sphere weighing 3·4 lb. It failed to orbit, the rocket system breaking in half about one minute after an apparently successful launching.

Vanguard was a three stage vehicle weighing 22,600 lb with a thrust of 27,000 lb. The second stage was liquid propelled.

EXPLORER II Satellite (Attempt)

Launched 5 March, 1958.

The satellite was cylindrical, 6 in dia. and 80 in long; it weighed 18·8 lb. Explorer II carried a small tape recorder for the investigation of cosmic ray phenomena.

VANGUARD I. Satellite

Launched 17 March, 1958, at 34·25° N.

Altitude: Apogee 2,466 miles, Perigee 409 miles.
Period of Rotation: 133·7 min. (approx.).
Weight and Dimensions: 6 in dia. sphere, weighing 3·25 lb.
Lifetime: The expected lifetime of Vanguard I is more than 2,000 years. After travelling for about 150 million miles through space, its tiny transmitter is still sending out a steady stream of signals. It is expected that its solar batteries will provide power for several centuries.

EXPLORER III. Satellite

Launched 26 March, 1958, at 33·37s N.

Altitude: Apogee 1,735 miles, Perigee 125 miles.
Weight and Dimensions: 80 in long, 6 in dia., weighing 30 lb.
Lifetime: In orbit until about 28 June, 1958, when it disintegrated.

Launched by a Jupiter C rocket, Explorer III sent back information which indicated that man could control the temperature within a space vehicle to make it acceptable for human survival.

VANGUARD. Satellite (Attempt)

Launched 28 April, 1958.

The satellite, which failed to orbit, was a 20 in dia. sphere, weighing 21·3 lb.

VANGUARD. Satellite (Attempt)

Launched 27 May, 1958.

The satellite, which was similar in dimensions to the 28 April attempt, reached a height of 386 miles before burning out. The failure of Vanguard's second stage to cut off properly caused the vehicle to continue nose upward instead of leveling off into orbit.

VANGUARD. Satellite (Attempt)

Launched 26 June, 1958.

A similar satellite to the two immediately previous ones. Failed at ground level.

EXPLORER IV. Satellite

Launched 26 July, 1958, at 50·82° N.

Altitude: Apogee 1,379·8 miles, Perigee 157·3 miles.
Weight and Dimensions: Bullet shaped, 80 in long and 6 in dia., weighing 38·43 lb.
Lifetime: Expected to last until about August this year. It sweeps a band 7,000 miles wide around the earth, between 51° N. and 51° S.

It contains two geiger counters (one shielded with $\frac{1}{8}$ in layer of lead); two scintillator counters, to measure the total amount of energy flow from the radiation; a 10 mW and a 30 mW transmitter. Two dipole aerials form part of the satellite's skin.

The launching vehicle was a modified Jupiter C rocket which consisted of four stages:

Stage I. A modified Chrysler Redstone missile.
Stage II. 11 scaled down Sergeant solid rockets.
Stage III. 3 solid rockets.
Stage IV. 1 solid rocket, forming part of the orbiting vehicle.

Explorer IV provided considerable information about the natural radiation belt which surrounds the earth.

THOR ABLE I. Lunar Probe (Attempt)

Launched 17 Aug., 1958, at 22·5° N.

Altitude: 40,000 to 70,000 miles.
Weight and Dimensions: Payload unit of fibreglass weighing 85 lb and carrying 25 lb of instruments. The lunar probe was toroidal in shape, 30 in long and 29 in dia. The total weight of Thor Able was 52 tons.
Lifetime: 77 seconds after take-off, Thor Able exploded, 10 miles out at sea. The suspected cause of failure was a ruptured JP fuel or liquid oxygen line.

EXPLORER V. Satellite (Attempt)

Launched 24 August, 1958.

This was a 25·8 lb cylinder, 80 in long and 6 in wide. It failed to orbit due to unexpected thrust generated in the first stage.

VANGUARD. Satellite (Attempt)

Launched 26 Sept., 1958.

A 20 in dia. sphere weighing 21·5 lb failed to orbit.

PIONEER I. Lunar Probe (Attempt)

Launched 11 Oct., 1958.

Altitude: 79,173 miles.
Weight and Dimensions: An 87·2 lb rocket probe including a fibreglass instrument package of 39·2 lb, top shaped, with a maximum dia. of 29 in, length of 30 in and depth of 18 in. The 88 ft 4 stage rocket weighed 52 tons.
Lifetime: About 43 hours.

The suspected cause of failure was an error in the final stage autopilot which lifted the trajectory 3·5° too high. The velocity was 35·25 f.p.s. less than the 36,900 f.p.s. needed to escape the earth's gravitational pull.

Pioneer's radiation measurements indicated a band with a maximum intensity at about 5,500 miles, tapering off to about one tenth of maximum intensity at 60,000 miles.

BEACON. Satellite (Attempt)

Launched 23 Oct., 1958.

A 9·26 lb 12 ft dia. (inflatable) sphere—failed to orbit.

PIONEER II. Lunar Probe (Attempt)

Launched 8 Nov., 1958.

Altitude: 1,000 miles, before burning out over Africa.

Cause of Failure: The first and second stages of the Thor Able vehicles performed successfully and separated from the upper stages. The third stage then failed to ignite.

PIONEER III. Space Probe

Launched 6 Dec., 1958.

Altitude: About 65,000 miles.

Weight and Dimensions: A 12·95 lb gold-plated conical shaped pay load, 20 in long and 9 in dia.

Lifetime: 38 hours 6 mins.

Launching Vehicle: 4 stage Juno II rocket, weighing 60 tons.

Pioneer II supplied valuable data on radiation bands.

PROJECT SCORE. Satellite

Launched 18 Dec., 1958, at Cape Canaveral.

Altitude: Apogee 928, Perigee 114·5 miles.

Weight and Dimensions: An Atlas intercontinental ballistic missile, weighting 8,750 lb went into orbit. The shape was cylindrical, being 80 ft long and 10 ft in dia. The pay load was 168 lb.

Lifetime: About 13 months.

Score, which was powered by three liquid propellent rocket engines, relayed President Eisenhower's Christmas message.

VANGUARD II. Satellite

Launched 17 Feb., 1959, at Cape Canaveral.

Altitude: Apogee 2,050 miles, Perigee 335 miles.

Weight and Dimensions: 20 in dia. sphere, weighing 21 lb.

Lifetime: More than 200 years.

The main purpose of Vanguard II was to measure distribution and movement of cloud over daylight of the satellite's equatorial orbit and to relate it to the overall meteorology of the earth. The surface of the satellite was treated with a special coating to facilitate optical tracking.

DISCOVERER I. Satellite

Launched into polar orbit, 28 Feb., 1959.

Weight and Dimensions: 19 ft long, weighing 1,300 lb.

The United States Defense Department announced on 5 March, 1959, that the Discoverer had achieved its north-south polar orbit, but on 17 March announced that it was " lost and presumed dead."

The launching vehicle for Discoverer I consisted of:

Stage 1. Modified Thor ICBM.

Stage 2. Bell " Hustler " liquid fuel engine.

PIONEER IV. Lunar Probe

Launched 3 March, 1959, at Cape Canaveral.

Altitude: It is estimated that Pioneer IV passed the moon at a distance of 35,000 miles. It is now in orbit around the sun.

It included a radio transmitter equipped to send signals continuously at a frequence of 960·05 Mc/s for about 90 hours, and two tubes for measuring the intensity of the two bands of earth-encircling radiation.

The launching vehicle was a 60 ton, 76 ft Juno II rocket.

Pioneer has sent back information indicating that the second radiation belt extends from 8,000 to 50,000 miles into space, and is less deadly than the inner radiation belt.

DISCOVERER II. Satellite.

Launched 13 April, 1959.

Altitude: Apogee 243 miles, Perigee 156 miles.

Weight: 1,600 lb. Payload: About 450 lb.

Lifetime: About one month.

An attempt was to have been made to catch an ejected capsule from Discoverer II but, due to a faulty timing device, the attempt had to be abandoned.

USSR

Although Russia took the lead in the " space race " when they fired their first satellite rocket just over 18 months ago, it is now impossible to say who is ahead. Of the 16 successful launchings so far, four have been Russian and twelve American. Russian projectiles have always been said to be heavier than those of the USA. However, they have a tendency to quote the weight of the entire mass in orbit, and note the useful payload.

In spite of some of their dubious claims, the USSR have undoubtedly achieved some significant " firsts." They were the first to launch a satellite; the first to put an animal (the dog Laika) into orbit; and the first to make a near approach to the moon.

Outside the " iron curtain," nothing is known of the unsuccessful launchings that the Russians may well have had, but of their successes, the following facts are known:

SPUTNIK I. Satellite.

Launched 4 October, 1957.

Altitude: Apogee 560 miles, Perigee 145 miles.

Weight: 185 lb.

Lifetime: About three months.

Sputnik I was equipped with two transmitters, working in the 7·5 and 15 metre bands.

SPUTNIK II. Satellite.

Launched 3 November, 1957.

Altitude: Apogee 1,056 miles, Perigee 150 miles.

Weight: 1,120 lb.

Lifetime: About six months.

In addition to its two transmitters and radiation measuring instruments, Sputnik II contained a dog, the now immortal Laika.

SPUTNIK III. Satellite.

Launched 15 May, 1958.

Altitude: Apogee 1,168 miles, Perigee 150 miles.

Weight: 2,919 lb.

Lifetime: About nineteen months.

Sputnik III is said to have contained an extensive range of instruments to make measurements and send back information on solar radiation; cosmic radiation; and ionospheric conditions.

LUNIK. Lunar Probe.

Launched 2 January, 1959.

Altitude: It is believed to have passed within 5,000 miles of the moon. It is now in a polar orbit.

Weight: 3,240 lb.

Lifetime: Indefinite.

UK

The part that Britain has played in the space era, so far, has been entirely confined to " ground-based " measurements. However, ours has not been an insignificant contribution. Although mundane, the British effort has been of considerable value. In the *Report on UK Observations of Artificial Earth Satellites and Associated Research*, published by the Royal Society, London, 1959, Professor H. Massey writes, " The effort made in the United Kingdom to extract the maximum of scientific information from the launching of artificial earth satellites has not only been on a considerable scale but also very effective.

A major contribution was made in the observation of the first Russian satellites for which the British data obtained by radio, radar and optical methods were of the first quality. Because of this, new information about the ellipticity of the earth has been forthcoming at an earlier stage than expected.

Valuable contributions have also been made to the study of the effect of air drag on satellites and its interpretation in terms of air density. The indications from this work about the variability of this density are among the most interesting of the discoveries made from the study of satellite orbits.

Much progress has been made on the study of radio propagation from the Russian satellites and it is abundantly clear that this will yield results of first rate importance for the understanding of ionospheric behaviour.

The value of British observations of telemetred signals from the Explorer satellites has been recognised by the USA, and the Jodrell Bank radio telescope has proved to be of vital importance for the reception of radio signals from the American lunar probes."

MEETINGS AND PAPERS

British Computer Society

LONDON
" Early Experience with an Electronic Data Processing Installation," by T. C. Hickman. Northampton College of Advanced Technology, St. John Street, EC1. Tues., 12 May, 6.15 p.m.

British Institution of Radio Engineers

LONDON
" Improving Communication Techniques: What Have Engineers to Learn from Information Theory? " by Professor D. Gabor. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 13 May, 6.30 p.m.

Chemical Engineering Group

LONDON
" Fuel Economy in Chemical Works," by W. Quick. Tues., 12 May, 6 p.m.

Chemical Society

EXETER
" The Acetylenic Approach to the Synthesis of Natural Products," by Professor R. A. Raphael. Exeter Branch. Washington Singer Laboratories, Prince of Wales Road, Exeter. Fri., 22 May, 5 p.m.

Engineers Guild

CARDIFF
Luncheon Meeting. South Wales and Monmouthshire Branch. Old Arcade Inn, Church Street, Cardiff. Fri., 15 May, 12.45 p.m.

Institution of Civil Engineers

LONDON
Open Meeting. Tues., 12 May, 5.30 p.m.

Institution of Electrical Engineers

LONDON
Discussion on " Trends in the Teaching of Electric Machine Theory in the United States," opened by P. L. Alger. Education Discussion Circle. Mon., 11 May, 6 p.m.
" The Application of Statistical Techniques to the Electronic Valve Industry," by E. G. Rowe. Radio and Telecommunication Section. Wed., 13 May, 5.30 p.m.
Annual General Meeting, at 5.30 p.m. " On the Conceivable Future of Telecommunications," by Professor E. C. Cherry, at 6.30 p.m. Thurs., 14 May.

CATTERICK
Open Meeting. North Midland Centre. H.Q. Mess, School of Signals, Catterick Camp, Yorkshire. Tues., 12 May, 6.15 p.m.

RYDE
" Indoor Lighting Systems: A Practical Comparison of Light Output and Costs," by E. Beaumont. Southern Centre. Ryde Castle Hotel, Ryde, Isle of Wight. Thurs., 14 May, 6.30 p.m.

Institution of Engineering Designers

BRADFORD
Annual General Meeting. Yorkshire Branch. Midland Hotel, Bradford. Wed., 20 May, 7.30 p.m.

Institution of Mining and Metallurgy

LONDON
Annual General Meeting (open only to corporate and non-corporate members of the Institution), at 4 p.m. Tea at 4.30 p.m. Presidential Address on " Some Observations on Gold Refining and the Standard for Gold and Silver Coinage," by Dr. J. H. Watson, at 5.15 p.m. Geological Society, Burlington House, Piccadilly, W1. Thurs., 21 May.

Institution of Public Health Engineers

LONDON
" Facts About Air Pollution from Homes and Factories," by R. L. Brown. Caxton Hall, off Victoria Street, SW1. Thurs., 14 May, 6 p.m.

Institution of Structural Engineers

PLYMOUTH
Annual General Meeting. South Western Counties Branch. Duke of Cornwall Hotel, Plymouth. Fri., 15 May, 6 p.m.

Physical Society

LONDON
Presidential Address on " Recent Trends in the Theory of the Ionosphere," by J. A. Ratcliffe. Annual General Meeting. Royal Institution, 21 Albemarle Street, W1. Thurs., 21 May, 5.30 p.m.

KINGSWOOD
Science Meeting. Optical Group. British Broadcasting Corporation's Research Laboratories, Kingswood, Surrey. Thurs., 14 May, 3 p.m.

Royal Aeronautical Society

LONDON
47th Wilbur Wright Memorial Lecture by C. J. McCarthy. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Thurs., 14 May, 6 p.m.

Royal Institution

LONDON
" The Modern State and Modern Society: Historic Tendencies and Future Probabilities," by Dr. G. Kitson Clark. Wed., 13 May, 9 p.m.

Royal Society

LONDON
Various short papers for reading and discussion. Thurs., 21 May, 4.30 p.m.

Royal Society of Arts

LONDON
" Trade and the Bamboo Curtain," by the Earl of Verulam. Wed., 20 May, 2.30 p.m.

Society of Instrument Technology

LONDON
Annual General Meeting of the Data Processing Section; and " A Multipoint Digital Strain-Gauge Recorder," by J. R. Sturgeon. Manson House, Portland Place, W1. Wed., 13 May, 6 p.m.

MANCHESTER
Annual General Meeting. " Temperature Measurement with Resistance Thermometers," by C. K. Massey. Manchester Section. Central Library, St. Peter's Square, Manchester 1. Tues., 12 May, 6.30 p.m.

NEWCASTLE UPON TYNE
Annual General Meeting. Newcastle Section. Stephenson Buildings, King's College, Newcastle upon Tyne. Wed., 20 May, 7 p.m.

South Wales Institute of Engineers

CARDIFF
Paper on " Switchgear." Thurs., 14 May (This meeting has been cancelled.)

Women's Engineering Society

LONDON
Discussionon " Aerial Survey Methods." London Branch. Hope House, 45 Great Peter Street, SW1. Thurs., 21 May, 7 p.m.

On the Shelf

By Frank H. Smith

When it was first announced for publication I do not remember that the *LLU Translations Bulletin* was advertised as being exclusively Russian in flavour, but that certainly is the impression one gets at the moment. In which case the title needs some specificing (with the " c " hard as in the latter half of icicle). The April issue concentrates on the Russian literature on the translation of foreign languages, which is just what we are doing about Russian so it is all that business of looking into parallel mirrors again.

Pergamon Press are catering for solid state physicists (and what a picture *that* conjures up) with *Solid State Physics USSR* at about £20 per annum of six numbers (if that is what is meant by bi-monthly). Maybe it's 24 numbers but either way Pergamon will send you a leaflet if you ask. Perhaps it is I who am solid.

The Safety in Mines Research Establishment (Portobello Street, Sheffield 1) is including 5 by 3 filing cards in its reports. These cards conform to the usual pattern—title, author, UDC, abstract and so forth.

Happy days of smelly but efficient cycle lamps are conjured up by the receipt from Union Carbide Limited, 103 Mount Street, London, W1, of their *Literature List*. These appear to be reports prepared by Union Carbide's staff, in this case on production, properties, fabrication and uses of alloy steels and iron. They are free from the library so I suggest you write for a copy of the list. But there's no mention of the dear old Lucas Silver King. Remember how you had to leave it outside after you'd blown it out?

Up the wrong tree, bruised shins, Crufts and the far end of the District Line are all on the way out. For ninepence you can obtain from HMSO the United Nations publication " Provisional Protocol for the Testing of Barking Machines." Cub's honour, it's true. It starts: " The barking machine must be new; the director of the testing station or his deputy shall select it from a stock of barking machines of the same model. The barking machine shall be run in and adjusted by the manufacturer or the testing station and under control of the station." My barking machine runs jolly well but it will stop at lamp posts.

" This periodical will provide a medium for reporting new and improved methods of disseminating scientific information and news of projects, grants, surveys and cooperative undertakings . . ." says the National Research Council about *Science Information News* which starts No. 1 of Vol. 1 in February-March, 1959. No price is indicated so I assume that a foundation that gives away dollars like confetti is affording this on the house. No harm in trying it on with National Science Foundation, Office of Science Information Service, Washington 25, DC.

I get a great kick out of house journals (ever seen the one from Whitbread?) and I found the list of awards in the 1959 National House Journal Competition (of the British Association of Industrial Editors) most interesting reading. Two of the top awards went to the motor industry (Nuffield and Vauxhall) and a third to the Ministry of Labour and National Service. It is quite amazing how many of these non-profit-making journals there are and what a variety of fields they represent. They seem all to have got an award of some kind or another.

We've fallen for it! " As of " the issue of 24 April, *Aeroplane* is called *Aeroplane and Astronautics*. A nice mixture of the concrete and the abstract. " Space " is, of course, another title that American journals like to incorporate but it's probably a thing of which English journals have not enough.

For nothing at all (which is the same in all currencies) you can obtain from Beuth-Vertrieb GmbH, Uhlandstreasse 175, Berlin W15, a list of the translations (into English) of some 500 German industrial standards.

APPLICATIONS OF Z-TRANSFORM THEORY

Sampled-Data Control Systems. By JOHN R. RAGAZZINI and GENE F. FRANKLIN. *McGraw-Hill Book Company Incorporated, 330 West 42nd Street, New York 36, NY, USA.* ($9·25); and *McGraw-Hill Publishing Company Limited, 95 Farringdon Street, London, EC4.* (74*s*)

In many areas of engineering activity today there is a rapidly growing interest in systems involving sampling. Data from a scanning radar, for example, are inherently discontinuous, likewise the output from a digital computer used to control some process or machining operation. Due to the difficulty of designing sampling systems by conventional methods and to unfamiliarity with the newer ones the advantages of these systems over those operating with continuous data have not yet been generally appreciated. These can include higher accuracy and a better transient response. Should the latter appear surprising one should remember that no information is lost in sampling provided the rate exceeds twice the highest frequency present in the function concerned.

One object of the book is to instruct in the use of a mathematical tool, the z-transform, which has been evolved in recent years for the analysis and synthesis of such systems. The z-transform of a function $f(t)$ may be expressed simply as

$$F(z) = f(0) + z^{-1}f(T) + z^{-2}f(2T) + z^{-3}f(3T) \ldots + z^{-n}f(nT) + \ldots$$

in which the summation extends to infinity. Each term consists of the value of the function $f(t)$ at the instant at which it is sampled multiplied by a negative power of z which serves as a sort of identifying label that remains throughout all the subsequent algebraic processes until finally removed by an inverse operation. The power of the method stems from the fact that in the linear systems normally encountered, these transforms can be written in closed form, and this with relatively little labour if tables are used. The transform of an input sequence multiplied by the pulse transfer function of the system (that is, the transform of its impulse response) yield the transform of the output sequence. There is close analogy between the z-transform and the Laplace transform, and indeed z, which is defined as e^{sT}, will be recognised as the multiplying factor corresponding to a time shift equal to the sampling interval T. It is worth mentioning that the sequence yielded by an inverse transformation can always if necessary be obtained by a simple numerical process, thus avoiding a difficulty often encountered in the analysis of continuous systems.

For synthesis, which is of course more difficult, several methods are available. These are explained in detail, and guidance is given as to which should be used in particular circumstances. Engineers familiar with conventional methods associated with the names of Nyquist, Bode and Nichols will have little difficulty in assimilating the approximate methods applicable when the sampling frequency is high, and for this the z-transform is not needed. Exact design methods are necessary, however, when the lowest practicable sampling frequency is approached and although both frequency and time domain methods are available, the latter, in the present state of the art, is the more easily applied. Extensions to the theory enable the ripple between sampling instants to be evaluated and the behaviour of a system with random input to be calculated statistically. Also, since the z-transform is essentially concerned with solving difference equations, the methods are applicable over a much wider field, including the approximate numerical solution of problems not involving sampling at all.

It is a pity that an otherwise excellent book should be marred by weaknesses in the table of transforms, which is by no means as extensive as it might have been, nor are the forms of certain of the expressions well chosen. Transform number 15 is incorrect and should be

$$\frac{(e^{-aT} - e^{-bT})\,z^{-1}}{(1 - e^{-aT}z^{-1})(1 - e^{-bT}z^{-1})}$$

The reader may also be puzzled by the use of the symbol δ to signify both a Dirac impulse and differentiation and misled by terms printed as $\sin aTz^{-1}$ where $(\sin aT)z^{-1}$ is intended.

Active development of the theory dates from the Second World War and, as a comprehensive bibliography reveals, has proceeded not only in the United States but also in France, Britain and USSR. A diversity in nomenclature and presentation has previously complicated quite severely the task of the newcomer, and this book, the first to be devoted entirely to the subject, undoubtedly meets a growing need. It is on the whole well written, the theory being developed logically at a tempo which anyone familiar with the Laplace transform and the principles of control system design should be well able to follow. The subject is not an easy one, however, and the value of the authors' teaching experience is evidenced by the many tutorial examples which lighten the task of acquiring the new technique. The student who is prepared to persevere will find his endeavours richly rewarded.

WATER POWER PRACTICE CIRCUMSCRIBED

Hydraulic Turbines: Their Design and Equipment. By MIROSLAV NECHLEBA. Translated from the Czech by CHARLES MAYER and A. G. EVANS. *Artia, Prague, Czechoslovakia;* and *Constable and Company Limited, 10-12 Orange Street, London, WC2.* (45*s*)

While engineers (as well as scientists) pay lip service to the ideal that science knows no frontiers, there is nevertheless a distinct division of the world of technical literature into three camps. American textbooks, almost without exception, draw their source material exclusively from within the United States: for example, the present reviewer has on many occasions come across major electrical engineering works in which the standard frequency is given simply as 60 cycles per second, with no reference at all to the fact that practically all the world's power supplies outside the United States are given at 50 cycles per second. Long lists of references at the ends of chapters almost always allude only to United States literature and practice.

The second camp exists in the Soviet bloc, where the bulk of the references are to practice in the USSR, Czechoslovakia, Poland and occasionally in Yugoslavia. Although Russian engineers are rapidly becoming more informed on practice in the West, most of the literature seen by this reviewer, either in Russia or outside, is largely as " insular " as that from America.

As for the third camp, it includes the industrialised European countries and Great Britain, and can in general be said to embrace a much wider world perspective than that from the United States or the USSR: but it is still rare, within the writer's experience, to find, from any source, a textbook with as wide a viewpoint as that which can be gained, say, from a survey of the papers presented to any session of the World Power Conference.

With these thoughts in mind, the first impression gained from an initial foray into the pages

of Dr. Nechleba's almost monumental treatise was that here at last was a book written from an Olympian viewpoint, equally and impartially citing Eastern and Western practice. References were seen to French, British, American and Canadian literature; tables of typical constructional layouts included data from many countries. And then as a more detailed perusal began, disillusion set in: but first it is desirable to dwell on the many virtues of the book. It is obviously addressed far more directly to the professional engineer and designer than to the student. It assumes a high level of mathematical knowledge and a solid background of appreciation of basic engineering design.

It is divided into four parts: introduction to the theory of hydraulic turbines; turbine design (further subdivided into sections on Francis, propeller and Kaplan turbines and Pelton turbines); equipment of hydraulic turbines; and starting and operation.

There is an extremely thorough and exhaustive study of every detailed aspect of hydraulic turbine design. Consider one example. In approaching the general subject of propeller and Kaplan turbines, the author starts with a theoretical introduction, 10 pages long, into the mathematical basis of the flow of water round blade forms applicable to this class of turbine, and a further six pages to the evolution of equations for the application of "airfoils" (sic) to the design of turbine blades. Then there is a further 12 pages on the aerodynamic properties of aerofoils, followed by two on the variation of the lift coefficient for wings arranged in a lattice system, three on the interrelationships of the velocity diagrams of the flow surfaces and nine on the control of the cavitation coefficient. Then five more pages are devoted to the stability of flow along the blade, and strength control and hydraulic load of the runner. Thus equipped, the reader is launched into the actual design of a machine.

Throughout the book this same logical thoroughness of approach is maintained. There is no doubt that any engineer fresh to hydroelectric practice would find in it a most valuable and comprehensive guide to the essentials of turbine design. But one has to consider the readership for which the book is intended—serious practitioners in water power engineering. They must already know the essentials of the art, or they would not be purchasers or readers of this book. What then would they expect to gain by studying its contents?

Percipient readers might well hope, as this reviewer hoped after the first glance, to find a book in which the latest modern practice, whether from East or West, is set out, perhaps compared, certainly analysed. Instead, the bias towards Soviet-influenced techniques is extremely strong. Nothing later than about 1953 appears to have come the author's way. Much standard Western literature is ignored. There is no reference to the work, for example, of W. P. Creager, whose American *Hydroelectric Handbook* is a classic.

In recent years, among important developments in hydroelectric engineering (on the turbine side) have been these: the evolution (mainly in France) of the bulb-type totally submerged hydrogenerator unit (which enables many schemes, previously considered to be uneconomic to be brought within the bounds of practical possibility); the marked increase in the number and size of pumped storage plants; and the evolution (mainly in Sweden) of refined governing methods, hinging on the use of electronic equipment. It must amaze any reader, as it did this reviewer, to find that not one of these three trends is mentioned. It is particularly surprising to find a total neglect of pumped storage plants, because the use of the turbine as a pump is of especial interest to the turbine designer, and much of the pure design data in this book could have been extended a little so as to be applicable to pumping or turbining. There are frequent references in the text to Thomann's *Die Wasserturbinen and Turbinenpumpen*, which (if memory of an English review serves) deals in great detail with the use of large turbines as pumps: but in any case the technical literature on this subject has been appearing in increasing quantity for at least a decade. The 1950 World Power Conference (called, in the book, the "World Congress of Energy") had several papers on pumped storage plants, and subsequent conferences have dealt with it as a main subject.

Similarly, the fascinating bulb-type unit was reasonably well known to hydroelectric engineers at a date at least earlier than 1953, which appears to be the deadline adopted by the author. As a further consequence of this cut-off of information for the last six years, all the figures given for the "largest units in the world" are no longer applicable.

There is much reference in the text to Czechoslovak standards, and design data are often related to them: for example, we find "Apart from controller switching tests also output, head and flow rate are measured in the course of guarantee tests (of water turbines and associated gear). These value (sic) are needed for efficiency calculations. Methods and evaluations of measurements are prescribed by the Czechoslovak Standard Specification ČSN 085010-1951. Therefore we shall not discuss these tests in detail." In this relatively brief section on starting operation and guarantee measurements, by the way, there is no mention of the most modern methods of flow measurement. The pitot tube and the salt techniques are ignored in favour of the exclusive use of measuring propellers.

The translators (from the Czech original) C. Mayer and A. G. Evans faced a difficult, involved and enormous task. On the whole, they succeeded admirably: but it is suspected that English was not the native language of at least one of them, because of phrases like "A shortcoming of this arrangement was that the sealing of the pins in the space of the high pressure water was connected with difficulties." The printing and general production, carried out in Czechoslovakia, is excellent. The line diagrams which make up most of the 534 illustrations are also first class, but the photographic illustrations are badly reproduced and in most cases unhelpful.

If this book had been called "The Present State of Hydraulic Turbine Design in Czechoslovakia" it could have been received with (slightly modified) rapture. As it is, one sadly reflects that here, in this very considerable enterprise, was a chance to unite Eastern, European and American practice in this vital art, and so to produce a volume that could be eagerly welcomed in all parts of the world: and the chance has not been taken.

NEW BOOKS

Commercial and Industrial Photography. By DAVID CHARLES. *Chapman and Hall Limited, 37 Essex Street, London, WC2.* (52*s* 6*d*)

A man who knows his job imparts a lifetime of knowledge to the reader. Not fancy stuff but "down-to-earth" instruction from an author who has done it all.

Chambres d'Équilibre. By ALFRED STUCKY. 3rd Edition. *Paul Feissly, Lausanne, Switzerland.* (32*F*)

Originally intended solely for the students of the Polytechnic at Lausanne "L'ouvrage traite des differentes methodes de calcul des chambres d'équlibre: bilan du travail, equations differentielles, differences finies (méthode de Pressel et méthode simplifié procédés graphiques de Schoklitsch et semi-graphique de MM Calame et Gaden.

Economic Operation of Power Systems. By LEON K. KIRCHMAYER. *John Wiley and Sons Incorporated, 440 Fourth Avenue, New York 16, NY, USA;* and *Chapman and Hall Limited, 37 Essex Street, London, WC2.* (96*s*)

The title fails to indicate that the book discusses the use of computers by electric companies to effect economies. The author has specialised in this work and though it is American the book should prove useful in this country.

MACHINE TOOL GEARING

Optimale Stufenrädergetriebe für Werkzeugmaschinen (Optimum Transmission Gearing for Machine Tools). By ERWIN STEPHAN. Berlin 1958. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf, Germany.* 102 pp. with 139 Figs., tables and index. (*DM* 25)

This is a design manual for the determination of the best transmission steps and gear-wheel arrangements for step transmissions as used in lathes and other machine tools where either the drilling or cutting speeds must be chosen, or where the advance of tools has to be controlled. The procedure followed is essentially based on German standards. The author has developed a handy semi-graphical method which makes it possible, with the aid of a slide rule, to find the most suitable arrangement to give optimum torque exploitation, minimum space, and proper step adjustment. Also determined are the gear-wheel dimensions, number of teeth and so on. The method is explained in the first part of the book. A second part is concerned with practical problems of layout. It is written in a clear manner, yet oddly enough, the symbols and graphs used are not explained at the beginning; hence the reader fights a losing battle in the appreciation of the author's good intentions until he reaches the key on a later page. This is scarcely a practical approach.

German literature is exclusively referred to. A clear definition of all special terms which are introduced in connection with machine tools would certainly help not only engineers in other fields but non-German readers as well. Besides, not everybody is so familiar with German DIN standards as the author supposes.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Merchants. HALL & CO. LTD., Victoria Wharf, Cherry Orchard Road, Croydon, Surrey. Brochure illustrated in colour describes the firm's activities in sand and gravel, coal and coke, slates and tiles, and building materials generally.

Instruments

Polarograph. MERVYN INSTRUMENTS, St. Johns, Woking, Surrey. The Mervyn-Harwell square wave polarograph Mark III is for the analysis of reducible metal ions in any ratio of concentrations. Illustrated leaflet.

Level Controller. FIELDEN ELECTRONICS LTD., Wythenshawe, Manchester. "Pneutronic" level controller provides output air pressure for operating diaphragm control valves. Transistorised for 12V d.c. supply. Sheet PN/1.

Instruments. CAWKELL RESEARCH AND ELECTRONICS LTD., Scotts Road, Southall, Middlesex. Oscilloscopes, noise meters, ultrasonic testers, delay units, stabilisers, etc. Catalogue.

Audio Oscillator. DAWE INSTRUMENTS LTD., 99-101 Uxbridge Road, Ealing, London, W5. Type 440 audio frequency oscillator has an output up to 6 W and a frequency coverage from 20 c/s to 20 kc/s working into 15 or 600 ohms. Leaflet.

Signal Generator. TAYLOR ELECTRICAL INSTRUMENTS LTD., Montrose Avenue, Slough. Signal generator model 68A/M frequency ranges from 100 kc/s to 240 Mc/s on fundamentals. R.F. output 100 mV; coarse and fine attenuation control. Leaflet.

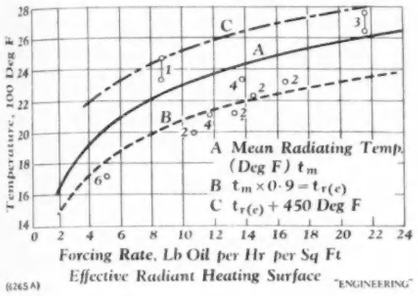
Conductivity Cells. ELECTRONIC SWITCHGEAR (LONDON) LTD., Works Road, Letchworth, Herts. Conductivity measuring cells for electrolytes; flow line, immersion and open tank types. Booklet CC/2 gives particulars.

Transducer. K.D.G. INSTRUMENTS LTD., Manor Royal, Crawley, Sussex. Pressure resistance transducers for pressures from 0 to 200 to 0 to 4,000 lb per sq. in. Accurate within ± 1 per cent. Leaflet RT/1.

MARINE BOILER REFRACTORIES

Constructional Materials for Known Service Conditions

The British Shipbuilding Research Association and the British Ceramics Research Association have been carrying out jointly for some years a programme of research aimed at improving the life of furnace brickwork in marine water tube boilers. The suitability of a refractory cannot


Temperature, 100 Deg F
Forcing Rate, Lb Oil per Hr per Sq Ft
Effective Radiant Heating Surface
A Mean Radiating Temp (Deg F) t_m
B $t_m \times 0{\cdot}9 = t_{r(e)}$
C $t_{r(e)} + 450$ Deg F
(6265A)
"ENGINEERING"

Maximum refractory hot face temperatures. Test results from boilers with exposed walls. (Numbers adjacent to points indicate boiler number).

be assessed without knowledge of the conditions of operation, and this research, recorded in a paper presented to the Institute of Marine Engineers,* concerns tests carried out on nine modern watertube boilers to determine the refractory hot face temperatures under actual service conditions. Results confirm basically what might be expected: that the design of oil burner, and therefore the combustion conditions, markedly affect brickwork temperatures, and that a knowledge of these allows installation of the most economic refractory material to give long life and easy maintenance.

FINDING SERVICE CONDITIONS

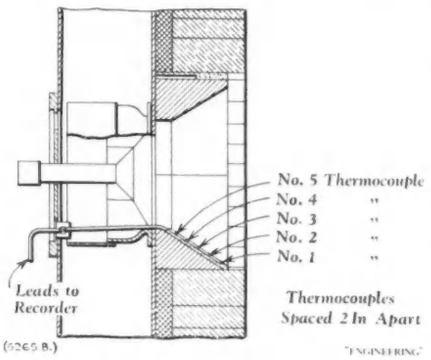
Important factors in life of linings are the operating temperatures, the rate and frequency of changes in temperature, and the degree of contamination by slag introduced from impurities in the fuel.

The boilers surveyed in this paper included most of the types commonly fitted in post war British tonnage. For temperature measurement platinum-rhodium thermocouples were used with a six channel automatic recorder, which allowed measurement at each point every four minutes. In two of the boilers, long impinging flames were produced with old burner designs. Three others, operating at higher pressures, had shorter flames, and there was little impingement of luminous gases on the back walls. The curves shown in the illustration were constructed by the authors, and show the calculated variation of mean flame radiating temperature with forcing rate—with air preheated to 240° F and with 30 per cent excess air. The experimental points, taken on exposed walls in the boilers, fall on to two curves, the one with the lower temperatures corresponding to the boilers with short flames, and the one with higher temperatures, to the boilers with long flames.

Because the actual flame temperature is greater than the mean radiating temperature, the refractory hot face temperature can exceed the mean radiating temperature where there is impingement of flames on the walls. The results of these authors, obtained under conditions of impingement, agree with those of previous workers, Sherman, Taylor and Karch. The authors conclude that a fairly accurate estimate of the temperature of an exposed refractory surface in a marine boiler can be made, and that for any one forcing rate, this will fall between the two curves corresponding to short flame and long flame conditions; which of these is applicable to a specific boiler can usually be predicted from a knowledge of burner design.

Measurements were made of the temperature of refractory walls shielded by water tubes, and it was concluded that for all practical purposes the steady operating temperature could be estimated from the curve of refractory temperature on exposed walls, by applying a factor depending on the spacing and diameter of the tubes.

Some of the most interesting measurements were taken on a quarl block shown in the diagram. High rates of temperature change were noted in shutting down or lighting up the



Arrangement of thermocouples in measurement of quarl block conditions.

boiler, and recorded curves indicated a maximum heating rate of 100° F a minute, and similar initial rates on cooling. In addition, measurements were taken in all nine furnaces at several positions, on back, front and side walls. In 15 out of 18 cases, the rate was greater than that required for cracking, which according to laboratory work on firebricks 9 by 6 by 3 in in size (or similar) was in excess of 10 to 15° F a minute, when heated from one end.

These observations on the conditions under which refractories operate provide the factual background which is necessary for confidence in choosing the correct material for lining a marine boiler. The authors went on to survey trends in refractories and methods of construction.

MORE MONOLITHIC LININGS

Important changes have taken place in both design and materials for linings. All monolithic construction has largely replaced the previous bolted block practice in boilers having water tubes in front of the walls; mouldable material is used for exposed sections such as floors and front walls, and castable material for cooler parts. In boilers without water walls, monolithic is fairly common for front walls, but brickwork remains most usual for the rest of the lining.

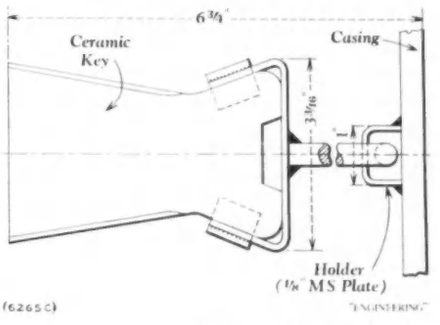
Monolithic, of course, implies one-piece construction, installed from mouldable or castable refractories *in situ*. Stability in mouldable mixes is provided by grog, which constitutes some three quarters or more of the dry weight of the mix. It is usual for firing to be complete only in the surface layers of such linings, so the hot face will develop a ceramic bond, while the cold face will remain unfired. Between the two is a zone of weakness. Securing devices are often buried in the lining, and one such ceramic device is shown in the illustration. It is essential that mouldable and castable materials should be correctly installed and a report has been prepared on the subject by the Marine Boiler Refractories Committee, which is a joint committee of the British Shipbuilding Research Association and the British Ceramic Research Association.

Monolithic linings have good resistance to thermal shock but are more prone to slag disintegration than firebrick. Their main advantage is ease of repair, but good results demand adequate keying to existing surfaces. In addition to the successful use of ceramic keys to support these linings, those in heat resisting metal are now used. Much improvement has resulted from the practice of welding these to the casing, which by eliminating the entry of air, has reduced the failures of keys due to oxidation.

The ease with which a concave shape can be made has enabled burner blocks to be angled and adequate clearance between the flame and lining to be maintained, and this in turn has enabled floor levels to be raised so that troublesome low side walls have tended to disappear.

MORE MIXED CONSTRUCTION

Several examples of burner quarls are given in the paper, one in excellent condition after four years of service; another repeatedly patched and spalled, in equally bad condition, after three years. Mouldable and castable materials are now very widely used for these blocks. While the mouldable material normally gives the better performance, castable material generally proves more convenient for repairing.



Design of ceramic key used with monolithic linings.

Slagging on quarl blocks themselves is not a problem even where heavy slag deposition is found on back and side walls.

Among the linings which are being increasingly used are South African and Australian firebrick, higher alumina bricks, and lower grade castable material to replace 42 per cent alumina firebrick.

The authors conclude that there is much interest in refractory problems among shipowners; not only are operating conditions of combustion chambers being improved by better design, but that the previous practice of lining chambers throughout with one class of material is ended. Mixed construction with high and low grades is current practice. Mouldable materials have greatly increased the life of front walls, and the introduction of pre-cast quarls of castable material has provided the basis for fast, satisfactory maintenance

* "Boiler Refractories: Operating Temperatures and Recent Developments in Construction," presented by McClimont, W., Richardson, H. M. and Taylor, B., to the Institute of Marine Engineers on 14 April 1959.

COMPRESSED AIR EXTINGUISHES OIL FIRES

VID BRAND!
I Öppna tilloppsventilerna A och B.
II Öppna och reglera erforderlig cisternventil.
III Starta kompressorn.
IIII Öppna påfyllningsventilen C.

This is not insanity—although it may seem so at first: if oil or petrol catches on fire, blow air through it. The method has been successful in fighting oil fires in the United States and, more recently, in Sweden. In this latter country, Mobil Oil have equipped their oil cisterns in the Malmo Oil Harbour with compressed air equipment; here, well trimmed compressors stand in readiness day and night. The directions for putting the system into action are illustrated—do they mean "turn on the compressed air and retire immediately?"

Now for some theory: the blast of air through the oil or petrol dilutes the vapour above the liquid; it does, however, cause evaporation, which while perhaps initially yielding an inflammable vapour, extracts latent heat and cools the liquid. Important factors to consider must be the rate at which heat from the flame returns to the liquid, the rate of evaporation, latent heat of the oil, and the concentration of vapour required for continued combustion.

The effectiveness of the system was demonstrated when 1,760,000 gallons of fuel oil were set alight in an open tank. The flames rose as high as 50 ft, but in less than one minute after compressed air had been admitted to the tank the fire was extinguished. Even petrol fires may be put out, although the method only reduces the height of the flames; sufficiently so, however, to enable foam extinguishers to be effective.

SINTERED TUNGSTEN SHANKS

Mallory No-Chat is a high density, tungsten based shank material which is now made in the United Kingdom by Johnson Matthey and Company Limited, 73-83 Hatton Garden, London, EC1. The modulus of elasticity is 40×10^6 lb per sq. in and the density is 16·96—a combination which when the material is used for tool shanks allows machining with increased feeds and with less vibration.

Let comparative tests speak for themselves: in the table are the results of machining EN24 nickel-chromium-molybdenum steel. The boring bars were 0·875 in diameter over an unsupported length of 5·125 in. The boring tool had in each case a 90° point, 5° trailing angle, 8° side and front relief, and 0·375 in overhang.

Mallory No-Chat has a thermal expansion coefficient of about 5×10^{-6} per degree C, and allows brazing of carbide tips without cracking or annealing of the shank.

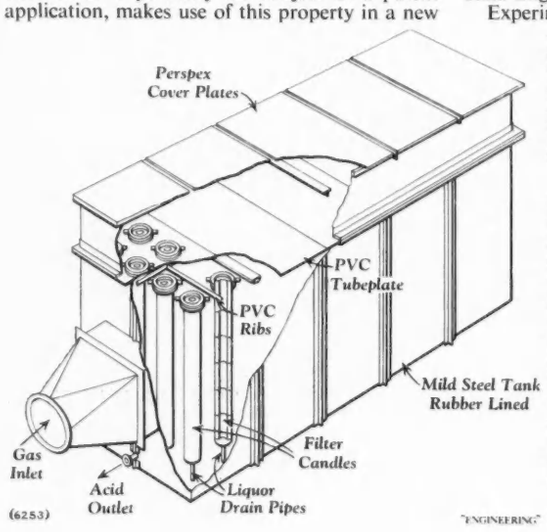
Rectangular bars in this material can be supplied in any size from $\frac{3}{16}$ in square to $1\frac{3}{4}$ by $1\frac{1}{4}$ in, and round bars in diameters up to 1 in, all up to 7 in in length.

Diameter of work piece, in	Speed of cut, f.p.m.	Feed, in	Depth of cut, in	Standard tool			No-Chat tool		
				Vibration	Swarf	Finish	Vibration	Swarf	Finish
$3\frac{1}{4}$	160	0·0095	0·062	Moderate ..	Chip ..	Good rough-cut	Nil	Coil	Clean
$3\frac{3}{8}$	210	0·0099	0·062	Heavy ..	Chip ..	Rough-cut	Slight	Coil	Clean
$3\frac{1}{2}$	285	0·0099	0·062	Very heavy	Tool collapsed		Slight	Coil	Clean
$3\frac{5}{8}$	296	0·012	0·062	—	—	—	Slight	Coil	Clean
$3\frac{1}{4}$	305	0·0163	0·062	—	—	—	Slight	Coil	Clean
$3\frac{7}{8}$	317	0·0208	0·062	—	—	—	Slight	Chip	Good rough-cut
4	326	0·0208	0·093	—	—	—	Slight	Chip	Good rough-cut

FIBRE FILTER EXPLOITS HYDROPHOBIA

Terylene and silicones are hydrophobic, and liquid particles impinging on fibres of these materials remain as discreet droplets. An invention which is presently the subject of a patent application, makes use of this property in a new type of filter, and is the result of research by the General Chemicals Division of ICI. Manufacturing and selling licences have been granted to Mancuna Engineering Limited, Denton, Manchester.

Experimental work was carried out with fibres of glass and Terylene, the former surface coated with a silicone such as ICI M441. The efficiency of pilot plant in separating sulphuric acid mist, which was 100 per cent below 2 microns at a concentration of 0·1 g per cu. m, was 99·4 per cent.



One proposed design of unit is illustrated, and has an assembly of preformed filter candles, each comprising 10 sections 6 in long, and capable of handling 200 cu. ft of air per minute with a 10 in w.g. pressure drop. This unit is called the Mancuna-Mister. A further, irrigated unit is the Mancuna-Fumex, which allows separation and recovery of strong acids or fine fumes of solid or liquid particles. One of these latter units worked with an efficiency of 99·8 per cent in separating fine particles of sodium monoxide, together with calcium chloride, sodium chloride, and chlorine, which were present originally in a concentration of 0·25 to 1 g per cu. metre.

AROMATIC EXTRACTION UNIT

A unit called the Udex is now in operation at the Stanlow refinery at Ellesmere Port, near Chester, for the production of an aromatic petroleum blending component for aviation fuels.

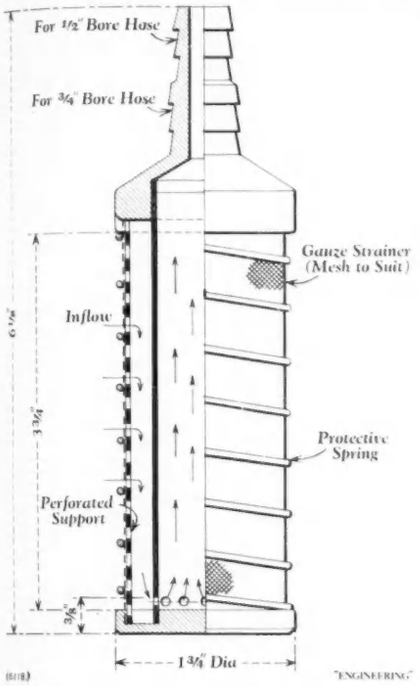
This unit is of the solvent extraction type using a solvent mixture of di-ethylene glycol, di-propylene glycol and water. The feedstock, which is a product of the Stanlow platformer, will be extracted with this glycol mixture which preferentially dissolves the aromatic components

of the feedstock. The aromatic extract is distilled off from the solvent and used in aviation fuel, while the insoluble non-aromatic portion, or raffinate, will be used as an additional feedstock for other processes.

Construction of the Udex unit began at the end of 1957; it cost £800,000 and—happily, has just completed a trouble-free acceptance trial. It incorporates six columns, the tallest of which is a 120 ft solvent stripper, and has a capacity of 1,000 tons daily. It was designed by Universal Oil Products Company of Des Plaines, Illinois, USA, and is the first of its kind to be incorporated in any shell refinery.

DRUM SUCTION STRAINER

A suction strainer intended primarily for providing a large straining area on the end of a suction pipe, and at the same time enabling the major portion of the contents of the drum or other narrow necked vessel to be drained, has been developed by H. T. Watson Limited, Croft Street, Widnes. The accompanying illustration shows the principle of the action of the strainer. It will be seen that the maximum diameter of the strainer is $1\frac{3}{4}$ in enabling it to be placed through the bung hole on drums and other narrow necked containers, such as carboys, and so on. The contents of the drum are drawn through a



large gauze surface down to the bottom holes on an internal suction tube and thence up through the outlet of the strainer to the pump or other suction device. The design of the strainer is such that the liquid can be drained to within $\frac{1}{8}$ in of the bottom of the container when the strainer is standing vertical, or to within $1\frac{1}{2}$ in of the bottom when the strainer is lying horizontal.

The strainer is available in various materials, but standard materials are brass and 18-8-3 stainless steel. The strainer is made in the one size shown at the moment, but is, of course, available in different sizes to special order.

IMPROVED PASSENGER VEHICLES

Some lesser known improvements in materials and engineering techniques as applied to omnibus design and operation were referred to by Mr. Ronald Cox, M.Inst.T., in a lecture he gave recently to the Institute of Road Transport Engineers.

Rayon and metal have been used in the walls of tyres in lieu of cotton, resulting in increased wall strength. Laminated glass and toughened glass are being used in increasing quantities for glazing purposes, and as replacement of toughened glass can be costly (templates are required), the glass is being pre-cut to shape before undergoing the toughening process. Rubber channel sections have superseded window pans, which means very much less expenditure on a first cost and replacement.

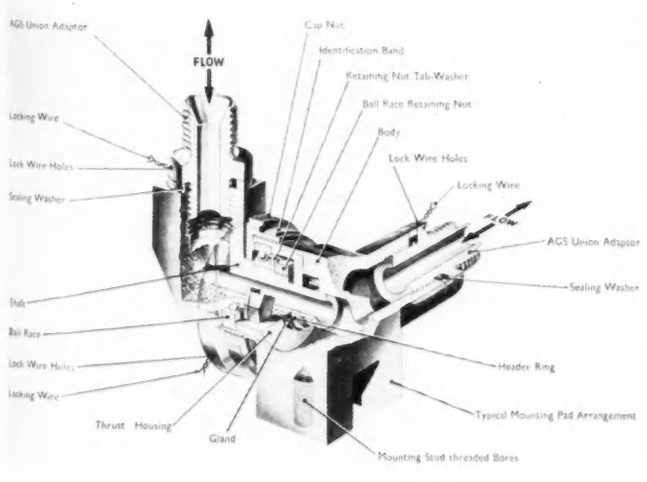
Efforts are being made by vehicle manufacturers to standardise on tyre and wheel sizes. Where front and rear tyre sizes are the same, the front tyres are used as retreads on the rear, effecting an extension of tyre life and a resultant saving in money. A tubeless tyre will be available for omnibuses before long; for those who prefer a tube, there is still the safety tyre which is especially helpful to drivers who may have the misfortune to have a front puncture. Consistency of wheel dimensions has received consideration internationally and complete standardisation for home and overseas is on the way.

Brake squeal is extremely annoying and very difficult to cure, but various types of anti-squeal bands have been designed successfully. Some moulded brake linings have a lower coefficient of friction than woven linings and, consequently, have a much longer life; providing a satisfactory standard of braking is achieved when they are fitted, it can become an economical proposition to use moulded liners.

Paper-pack fuel and oil filters are rapidly replacing the earlier types of cloth and gauze types of filters—manufacturers claim that paper pack filtration is more efficient and that they are easier to change than the earlier types of filters. Chromium plating of such parts as piston rings, shackle pins and king pins has been introduced to resist wear of bearing surfaces. Self-locking nuts are being used wherever possible.

SWIVEL PIPE COUPLINGS

For general industrial use, Avica Equipment Limited, Hemel Hempstead, Herts., have introduced a new series of swivel pipe couplings for hydraulic systems, to give maximum flexibility and to permit relative movement between components. The new Mark 3 couplings, which are based on experience gained over many years on aircraft and other special purpose applications, combine ruggedness with low operating torque. They are designed for operating pressures up to 4,000 lb per sq. in, and are available initially in $\frac{1}{4}$ in, $\frac{3}{8}$ in and $\frac{1}{2}$ in BSP pipe sizes. Two versions of the coupling are shown in the illustration alongside—one with 90° shaft and body outlets, and the other with a straight shaft and 90° body outlet. A straight shaft and straight body outlet version is also available, as well as a multiple unit. All components, other than the sealing gland and back-up ring, are in steel protected by cadmium plating, but other materials and finishes can be supplied to meet special requirements. The coupling is prepacked with grease and requires no periodic lubrication.

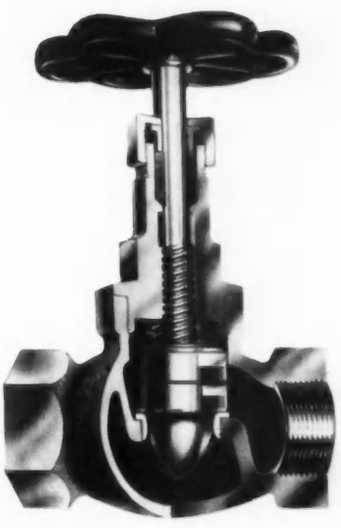


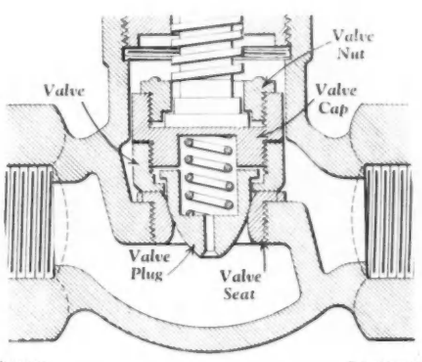
The new couplings have been subjected to exhaustive testing, including misalignment while functioning under full operating pressure, to establish the ruggedness of the design.

STEAM VALVE WITH STREAMLINE FLOW

A new control stop valve for use in steam lines is being introduced by Sir W. H. Bailey and Company Limited, Albion Works, Patricroft, Manchester. Known as the "Bi-Seat," the unit is a patented design which, it is claimed, affords a high degree of control and gives improved protection of the working parts. It is designed for controlling steam at working pressures of up to 300 lb per sq. in and temperatures as high as 500° F All working parts are made of K Monel and stainless steel to give a long and trouble-free life.

On initial opening, the main valve is raised





about $\frac{1}{16}$ in clear of its flat seat, but the orifice remains sealed by a spring-loaded parabolic plug. As the unit is opened further, the plug is gradually withdrawn from the orifice to provide a streamlined annulus for the passage of steam. This design makes it nearly impossible for foreign matter to be trapped on the main valve seat, and the fine degree of control—from minimum flow to full bore—allows steam to be admitted slowly to a cold system with full protection for the valve and seat against the direct cutting action of the high velocity steam, so preventing wire drawing.

The same high degree of protection is afforded to the seat when the control valve is being closed, because the steam is shut off by the parabolic plug before the main valve comes into close contact with it.

FIRE FLOAT FOR FIJI

Pump Carrying Pontoon with Built-in Propulsion Unit

Trials of a self-propelled fire fighting vessel, designed for specific duties in Suva, Port Fiji, have recently been carried out on Chelsea Reach. In view of the port's growing importance, and the development of the water front property, the Suva authorities have reviewed the fire-fighting arrangements, and as a result of negotiations with Merryweather and Sons Limited, Greenwich, placed the now completed order for a self-propelled fire-fighting float of the following dimensions :—length overall, 45 ft; breadth moulded, 13 ft; depth moulded to upper deck, 7 ft. 9 in; depth moulded to lower deck, 5 ft; draft, 2 ft 6 in.

Demonstrating the self-propelled fire fighting vessel Dautataro, which has been designed for service in Suva, Port Fiji.

" Dautataro," by which name the vessel is known, is strongly constructed of Siemens Martin mild steel and the design is on the single chine principle with box sections and scow ends, the after end being shaped to facilitate the flow of water to the Harbourmaster outboard propulsion unit housed on the after deck. The hull, which has been zinc sprayed to 6 in above the water line and painted red, has shell and topside plating of $\frac{1}{4}$ in mild steel and is of all-welded construction. The float is divided by bulkheads of $\frac{3}{16}$ in plate, with welded stiffeners, into three watertight compartments—fore and aft peaks and machinery space.

It was originally envisaged by the authorities that a barge type vessel should be constructed which would carry a fire pump, and would be towed by a tug when required for duty. As an alternative, a simple pump-carrying pontoon with built-in propulsion unit was considered. The fire-fighting engineers, however, having produced a highly efficient independent pumping unit specially designed for marine fire and salvage work, were able to put forward proposals which embodied considerable improvements.

Initial intentions were that the vessel should be built at Suva, and Merryweather appointed Courtney, Hughes and Partners Limited, of York Villa, Church Street, Twickenham, marine consultants, for the hull design with this in mind. Subsequently, however, the owners arranged for the entire vessel to be built in Great Britain, and the contract was awarded through the Crown Agents to Thames Launch Works Limited, Eel Pie Island, Twickenham, Middlesex, at whose yard the float has been produced. Messrs. Flannery, Baggallay and Johnson have supervised the construction.

The fire pump and equipment installed comprises a Merryweather 1,500 g.p.m. turbine fire and salvage pump of gunmetal construction, which is driven by a Leyland 680 marine oil engine capable of the following duties at fire-fighting pressures: 1,200 g.p.m. at 100 lb per sq. in; and 1,100 g.p.m. at 120 lb per sq. in. On salvage duties the pump can handle 1,800 g.p.m.

The fire-fighting equipment is so designed that foam and/or water can be thrown at will. The foam-making equipment includes a major foam generating unit capable of producing 1,800 gallons of foam per minute through a 5 in monitor. Other foam equipment includes two foam generating units each capable of an output of 600 g.p.m. through hose lines, and a further two units each capable of 300 g.p.m. through hose lines. Two engine girders extending over the full legnth of the machinery space form keelsons, and bearer plates are welded to the girders to bed the unit. The variety of nozzles supplied enables the firemen on board to deal effectively with any type of outbreak with which they may be faced. Of particular interest is the 1,000 g.p.m. firebreak nozzle which, used on the monitor, enables a flat curtain to be projected over a considerable area, a very valuable feature when preventing fire spreading from one building or vessel to another nearby. When operated in the vertical plane the firebreak throws a curtain of water which presents a most effective barrier. Miscellaneous Merryweather equipment supplied includes a salvage suction head, suction hose, canvas hose for delivery lines, as well as all valves and bends, which when not in use are stored on steel racks in the pump room. Two foam tanks, each with a capacity of 160 gallons, are arranged at the fore end of the pump room, one on either side; and at the after end of the compartment, one 160 gallon tank for fuel has been installed.

The engine space is on the after deck and installation is extremely simple. A transom slot is arranged to house the stem of the unit and the whole unit is complete in itself only requiring holding down bolts for its installation. No rudder is required as the power steering is effected by rotating the outboard stem below its watertight joint, thus turning the propeller through any required angle up to 360° in either direction. Such steering provides a degree of manoeuvrability, from the slowest speed upwards, not possible with the conventional rudder. The propeller is driven by a Lister FrM4A diesel engine through gearing to the propeller; the engine is governed at 1,600 r.p.m. max., to give a propeller speed of 487 r.p.m.

Other interesting features of the Harbourmaster are its suitability for shallow water operation and should the skeg of the unit beneath the propeller strike bottom when going ahead, the stem, through a patent friction lock, wills wing backwards and upwards, until it clears the obstruction. There is also a skeg plate welded to the hull forward of the propeller, which affords additional protection. Maintenance is considerably simplified since the engine and gear is so readily accessible, and clearing a fouled propeller or even changing a propeller can be quickly effected without recourse to beaching or dry-docking, by elevating the stem to its vertical inboard position.

TRIANGULAR SPINDLES FROM FLATS

Positive Location and Flexibility

A number of immediate advantages are obtained in small components by the use of triangular spindles made from flat brass strip. The Plessey Company Limited of Ilford are producing a small potentiometer with these spindles and the saving in production cost enables them to market a potentiometer with a moulded track at a price only slightly higher than that of the sprayed track type.

The design of the spindle is such that the need for machining special flats and knob fixings has been obviated, all locations and fixings being achieved by bending or forming the spindle. In the Plessey potentiometer the spindle also carries the polystyrene ring which, in turn, holds the brush gear. The limit stop and switch operating lug are also incorporated in the polystyrene ring. Another advantage concerns the control knob. Given a triangular bore it has positive location in three positions on the spindle. Furthermore, the inherent flexibility of the spindle prevents straining of the control.

The bush and back plate of the potentiometer are a one-piece zinc-based die casting, which gives great rigidity and accuracy of location. The insulation resistance is extremely good by virtue of the use of polystyrene.

Savings in production costs have enabled Plessey to make a potentiometer with moulded track for nearly the same price as one with a sprayed track.

FIXED BOBBIN STRANDING MACHINE FOR ELECTRIC CABLES

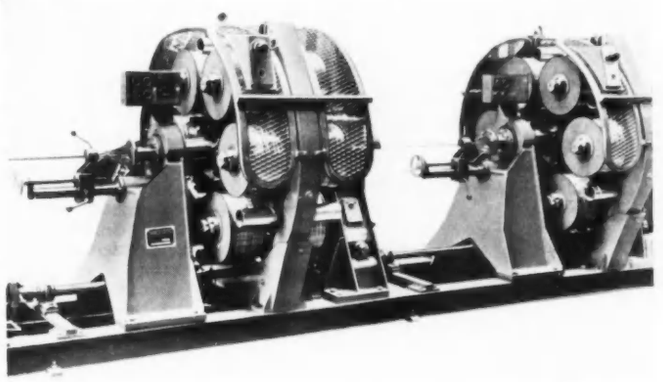
Higher Rotational Speeds and Shorter Loading Time

THE existing principle of stranding wire rope and electric cable was developed mechanically about 50 years ago from the methods used in the old manual system which involved what was then termed "a rope walk." This principle is quite sound, but speedier production is required today. After collaboration with the wire rope and cable manufacturers, Larmuth and Bulmer Limited, Todleben Works, Unwin Street, Salford 6, discovered that much production time is wasted during loading operations when the machine is idle. The company therefore decided that any new machine should incorporate methods to reduce loading time. However, the main step to increased production is a higher rotational speed of the bobbin head or bobbin-carrying tube, which carry heavy loads. The main problem was to "compact" the load to reduce the diameter of rotation in order to minimise the centrifugal force. In addition, a higher degree of accuracy in balancing was required, and therefore new methods of dynamic balancing were introduced.

The individual requirements of producers vary from factory to factory, and while some standardisation is desirable in order to manufacture a machine on a commercial basis, it was found possible to vary many of the individual preferences for change gears or variable speed drives, various types of haul-off capstans, and the inclusion or otherwise of certain items of electrical equipment. While contracting for individual machines in the wire rope and cable industry needs considerable care and attention, this has introduced some measure of simplification in tendering for the great variety of requirements encountered in the industry.

Among new machines recently announced by Larmuth and Bulmer is their fixed bobbin stranding machine for the electric cable making industry. Until recent years the sun and planet machine has been favoured for the production of multi-layer concentric stranded conductors. The machine produces the high quality stranding required but suffers, to some extent, from the method of accommodating the bobbins in large planetary cradles. The complete assembly is often expensive to manufacture and its bulk occupies large areas of valuable floor space. In addition, the speed of production is restricted to a limit of rotation governed by the nature of its construction.

The new fixed bobbin stranding machine will produce the same high quality stranding of the sun and planet method with a 50 per cent step-up of the rate of production on copper stranding and even greater when stranding aluminium. Initial capital costs are greatly reduced, and the neat and compact construction shows a great economy on floor space. The machine also incorporates many new features for automatic control, ease of loading and lower maintenance costs.



The LB fixed bobbin stranding machine is suitable for cabling hard or annealed copper strands from 0·045 in minimum up to 0·140 in maximum, or hard alloy aluminium from 0·045 in to 0·155 in. It consists essentially of either six or 12 bobbin heads carrying bobbins of 16 or 22 in diameter which can be arranged in any layer combination of six of 12 wires to produce multi-concentric cables.

Each section of the machine is arranged for independent rotation in both directions, and to increase the flexibility of the machine it can be assembled in tandem formation. Preforming heads can be incorporated when required.

Each rotating head is a steel fabrication in the form of a casing. This is mounted on a rigid hollow shaft supported at each end by roller bearing pedestals. The drive to the head is through machine-cut gears from a central transmission shaft which serves any combination of heads for multi-layer cables. A direct current variable speed motor provides sensitive operational control for adjustment to suit the types of cables produced. The slow speed running of the head is by additional gearing from the main drive. The gears are enclosed within a fabricated end frame and speed variations and reverse rotation are controlled by levers on this frame. The operator's control panel for stopping starting and "inching" the machine during loading is conveniently placed on the front of each head above the lay plate. Loading speeds range from 2·9 r.p.m. to 4 r.p.m., depending on the size of bobbin head.

The steel bobbins are machined and balanced. Large diameter bobbin arbors are fitted with a quick loading mechanism with a fast release and locking device. Each bobbin locates against a tensioning device in the form of pressure shoes easily regulated to ensure correct wire tensioning during stranding. Each bobbin spindle is fitted with electrically controlled and fully automatic stop motion. This is locked to the hydraulically operated main brake system acting on the head casing. The braking system is matched to the high speed of the machine and is regulated to stop rotation in 3 to 4 seconds in the event of wire breakage.

The wire travels from the bobbins around bearing-mounted traverse rollers and is located on a polished tungsten carbide wire guide through guide rollers and a pulley. The lay plate also has guides of tungsten carbide. The die box is supported on a spindle, and longitudinal adjustment is simplified by a hand-wheel-operated traverse screw.

A single haul-off capstan fitted with fleeting attachment is provided as standard, but the double "V" grooved type can be incorporated if preferred. The drive to the capstan unit is by means of helical gearing driven from the main drive by a shaft extension.

FAIL-SAFE TESTS ON BOEING

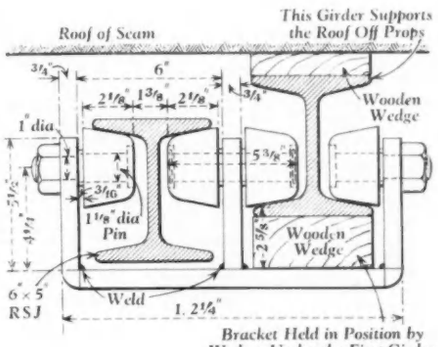
Some of the conditions imposed during hydrostatic fatigue tests on Boeing 707 jet airliners have been described in a note issued by the company from their Seattle headquarters.

Such tests were begun by Boeing in June, 1958. The forward fuselage and nose section employed had already undergone 50,000 "flights" or cycles of pressurisation—equivalent to 40 years of intensive service—when some additional "fail-safe" tests were attempted. Altogether, six saw cuts were made through stressed members and the skin, while the pressure tests were in progress. The largest cut began at 8 in long in the upper surface of the fuselage and was extended after every two cycles of pressurisation until its length reached 22 in. The other cuts were made in window frames, floor beams and door reinforcements. The company report that the damage did not spread in any instance.

During the fail-safe tests, the water pressure was applied inside the fuselage until it was 10·35 lb per sq. in greater than that outside. This compares with a maximum operating pressure differential of 8·6 lb per sq. in. Preceding these tests of the main structure were shock-load tests on the double-pane windows. These localised tests were made to prove the ability of the inner pressure pane to take the full air load should the outer pane ever fail. Stretched acrylic plastics is used for these inside panes, and even when deeply scratched they were found able to withstand the applied shock load.

ROLLER BRACKETS FOR TEMPORARY SUPPORT GIRDERS

A roller bracket to facilitate the advance of girders which are used to support the lip on coal faces where Anderton Shearer machines are in use, has been designed by an engineer at Nailstone colliery in the East Midlands Division. To use these brackets the girders are set in pairs, side by side, along the length and at right angles to the line of the face; the girders may be of any section and length. Three brackets are used on each pair of girders. Such brackets would be of value wherever "needles" have to be inserted and advanced as work proceeds.



Bracket Held in Position by Wedges Under the First Girder While the Second is Advanced

The brackets, which are illustrated in the accompanying diagram, are of welded 3 in steel plate, 3½ in wide, fitted with taper rollers of 3¼ in diameter. When the girders are to be advanced, the brackets are first tightened on to one girder by wooden lids or wedges. The bracket rollers will then support the second girder when the props are removed from under it, and the girder is moved forward on the rollers to its new position. This is done for all the girders along the face. The props are then re-set to support the advanced girders and, after the brackets have been tightened on to these girders, the same procedure is employed to bring forward the other girder. The brackets provide a simple but effective means of advancing supports quickly and safety.

GOOD DESIGN MEANS MASS ACCEPTANCE

Impact of Styling in the United States

THE question " What is an industrial designer ?" is no easier to answer than that older one of " What is engineering ?" A new OEEC publication *Industrial Design in the United States*, apart from all the other interesting things it contains, is noteworthy for attempting answers to both questions. Admittedly they are fairly complicated answers, but that is perhaps to be expected. An industrial designer, the report says, " aims at having a complete view of the product from all its aspects." He is involved with:

The application of: creative imagination and discriminative judgment.

In terms of: Form, colour, and texture.

In relationship to: Use, user, and environment.

With consideration to: Performance, structure, materials, manufacturing process, and distribution.

All of which shows how wrong it is to think the industrial designer is called in just to pretty things up or make them look " contemporary."

Engineering is defined as " all preparatory work of both a technical and economic nature that has to be performed before production can be commenced." Industrial design is seen as coming within this field of activity, although, says the report, " it has much in common with sales activity."

The main part of the report deals with the findings of a group of European engineers and designers (none of them British) who visited the United States as Project No. 278 of the European Productivity Agency at the end of 1955. In spite of the lapse of time since the investigation was carried out the report contains much interesting information, especially in the comparisons it makes between European and American methods and procedures.

Interest in industrial design in the United States developed from the sternly competitive days of the 1920's when it became clear that the best designed articles went on selling whereas the rest just went off the market. Another important step forward was the emigration to the United States of a number of German architects and designers. Most of these were followers of Walter Gropius, founder of the institution known as the *Bauhaus*. The mixture of the idealistic views of the *Bauhaus* on functionalism and American business acumen produced a modern industrial design philosophy. Today there are a large number of independent industrial design consultants in the United States, varying from one-man firms to offices with eight partners and 74 employees. The report states that the successful industrial designer is ready to cope with everything in the design field, from " trademarks and letterheads, packaging, window displays, consumer goods (small and major appliances, furniture, hardware) and producer goods (heavy industrial equipment) down to military equipment of various kinds (tanks, jets.) "

As a rule the industrial designer does not supply production engineering drawings. He works closely with his client's own design and engineering staff whom he teaches and trains in the application of his ideas to their particular product. As a rule the industrial designer is on a retainer basis, receiving a yearly sum for advice and work within certain limits. Specific jobs outside this arrangement will involve additional payments.

The report throws some interesting light on the aims of the industrial designer in different fields of activity. In industrial machinery his main concern is with the appearance of the product. When a new product is to be made a " product engineer " is given the whole responsibility for the pre-production and functional design work. Industrial design plays a rather bigger part in firms making consumer goods. All the larger American concerns in this field have their own design departments. The actual point at which industrial design comes into the picture varies from one product to another. Sometimes the work begins with styling, in others a final touching up is all that is wanted. Firms making a variety of products generally have an independent industrial design department common to all departments. This would be the case in a firm making, for example, washing machines, refrigerators, and cooking stoves. All these would be given the same " look."

Some consumer goods makers have a separate " advanced product design " section where imaginative suggestions and plans for the future are initiated. Apart from development work the product design department has the task of making and testing prototypes.

Industrial design is of greatest importance in the automobile industry, according to the report. The motor car is the most important item in the consumer goods category, and its sale is firmly based on the " concept of the year's model," Styling, which covers such things as size of tail fins, how many rear lights, how many square yards of chrome; and design, which deals with the moving parts, are of equal importance in this industry. The industrial design department in the car firms has a very independent status and is made directly responsible to top management.

The report gives a number of conclusions about the present and future functions of industrial design in the United States. Some of these are the results of the group's own observations, others are quoted as being the views of experts working in the field. The gradual disappearance of the independent consultant is foreseen as individual firms making industrial design an integral part of their organisations. Two views on the function of design are quoted. " Good industrial design means mass acceptance. No matter how beautiful a product may be, if it does not meet this test, the designer has failed in his purpose." This view was expressed rather differently as " the most important object of industrial design is to make the cash register ring."

The group's own recommendations include the organisation of conferences aimed especially at top management and explaining the advantages that might be gained by introducing American practices to European firms. Exchanges of information on training methods and knowledge in the industrial design field are also recommended. Improvement in educational facilities in order to increase the numbers of people trained in industrial design is regarded as of first importance. Such education would be partly artistic and partly technical, and should be provided at both technical school and university level. However, the movement of ideas is not all one way. The report states that America can learn something from Europe, especially from those industries where designers have managed to transfer " old handicraft traditions to modern industrial requirements," and from the influence of non-profit making bodies such as the British Council of Industrial Design.

CENTRALISED SIGNALLING AT NEWCASTLE CENTRAL

Intense Demands of Modernisation

During the years 1906 to 1910 the former North Eastern Railway adopted electro-pneumatic power signalling for Newcastle Central Station and its approaches on both sides of the Tyne, and installed ten signalboxes, together containing over 960 levers. These installations became modified in the course of time by the addition of a large amount of track circuiting and the abolition of one of the Gateshead boxes, its controls being transferred to another. Many years ago it was recognised that greater centralisation was desirable and recently the three signalboxes at the Central Station itself and the one at Manors Station, a short distance out, were replaced by a relay interlocking box of the route-setting type, working on the Westinghouse " one control switch " system, as applied in 1951 at York. Power is taken from two public supplies and no separate standby has been thought necessary.

The signalmen's operating console contains 641 switches, arranged in convenient groups, above which are an illuminated diagram, 53 ft long, and the train description indications, which change step by step as the trains occupy the different track-circuited sections. Behind the signalmen is the traffic regulator at his own desk with the necessary telephones. The relay room contains over 2,850 relays, involving 400 miles of single-core flameproof cable for wiring. The entire area is track-circuited, using a.c. reactance feed circuits and resonated double-element vane relays.

All running signals now are colour-lights, fitted where necessary with route indicators showing an illuminated symbol, while shunt and subsidiary signals are " position " lights, as already seen at other places. Point operation remains electropneumatic, but with improved mechanisms, and the air is supplied from two compressor stations with facilities for connecting mains through in case of failure. The main cabling is multi-core with paper insulation and lead sheathing and terminates at over 50 housings; protection is provided against possible fault currents or surges from the electrified lines.

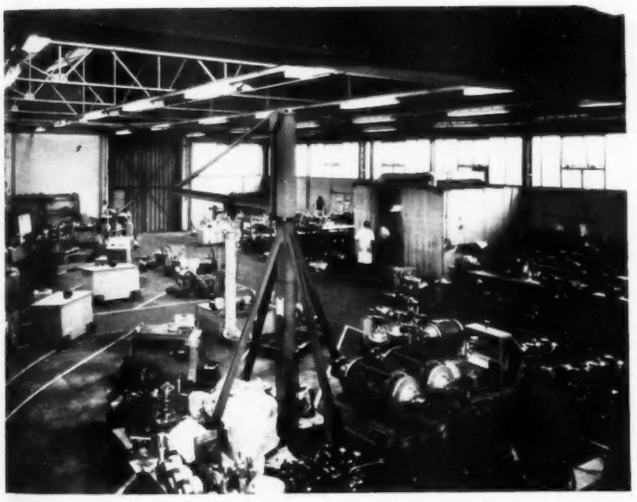
The train describing system is particularly complete, affording the signalmen and regulator the maximum information. Telephones are provided at all the signals so that train crews can speak to the signalmen, and the arrangements include numerous " plug-in " locations from which ground and maintenance staff can speak to the signalbox. At selected places there are loud speakers which can be made to sound a high frequency note to summon staff to the nearest location. There is also an electrically-controlled clock system throughout the area. The installation is another example of that centralisation of control, becoming so marked a feature of this class of work at the present day.

BATCH PRODUCTION OF HIGH SPEED HYDRAULIC PUMPS

HYDRAULIC pumps of the direct type, that is directly coupled to the machine for which they are supplying power, have many advantages over the older, slow-running equipment operating through accumulators. With the high-speed direct system the power required to drive the pumps is directly proportional to the work done by the press, and the speed of the press and the pressure it exerts can be controlled very accurately. A considerable economy in power consumption can be achieved by the direct system. Manufacture of the pumping equipment, however, has of necessity to be to much closer limits than would suffice for heavier plant. In addition, the valves and control gear have to be made to the same precision limits.

Towler Brothers (Patents) Limited, Rodley, near Leeds, whose "Electraulic" pumps and control gear are internationally known, made hydraulic equipment of the older, slow-running type prior to the development of their high-speed pumps in the 1930s, but manufacture of the older types ceased when the newer ones were in full production. Starting with a high-speed pump of the ram type, Towlers pioneered in this country the development of both in-line and axial plunger pumps together with suitable control gear, and from the beginning applied machine tool limits to the production of component parts.

From the simple pump with a hand control valve it was a logical step to develop a.c. solenoid valve control, followed by two-circuit systems (low pressure control and high pressure working circuit), and more complicated controls with d.c. solenoid operation and double circuits to meet the needs of modern production processes. Today, the company produce in-line and axial type pumps of various capacities, and complete control layouts ranging from simple hand controls, which still have their uses, to remote control systems giving manual, cam or sequence operation for fully automatic cycles. Provision is made in the design of the controls for operating a press or other hydraulic machine by means of punched cards or magnetic tape control to give a chosen and easily changeable automatic manufacturing sequence to a press or other machine.



Assembly of pumps and control gear is on a batch basis.

PRECISION FINISHES

Production of hydraulic pumping and control gear at Rodley is on a batch basis, the machine tools used being, on the whole, of orthodox types such as would be found in any other works engaged on high class engineering production work. It is in surface finishes and dimensional tolerances that the products are outstanding. Unlike the slow-running pumps and control gear the high-speed equipment has no hydraulic packing, and as working pressures of as much as 10,000 lb per sq. in are involved, the limits of surface finish on moving parts under pressure have to be extremely close. Dimensional tolerances on some components also have to be held to close limits.

Typical components where surface finish is important are the reaction plates and wobbler thrust plates used on the swashplate type axial pump. These items, in heat treated condition, are ground on a Blanchard surface grinder, lapped on a Flexibox machine and finally polished on a machine made by Towler Brothers to suit their own special requirements. Three component work spindles on an eccentric head, a Rexine face with rubber backing for applying the polishing pressure, and a normal commercial polishing compound are used to work the components to a final flatness accuracy of 4 light bands.

All holes for valve spindles or hydraulic rams are held to between + 0·0008 in and + 0·0006 in oversize. Typical components containing such holes are the valve bodies. These are drilled, bored, reamed to − 0·001 in and then honed to + 0·0004 in. Annuli are then cut in the body as required for the operation of the piston-type valve spindles, and the bodies are honed finally to the + 0·0008 in + 0·0006 in tolerance. Delapena honing machines are used for both honing operations, the stones being changed for finishing. A surface finish of 4 to 6 micro inches is obtained, and the tolerances allowed for roundness and parallelism are half that permitted on the diameter, regardless of the length of the hole.

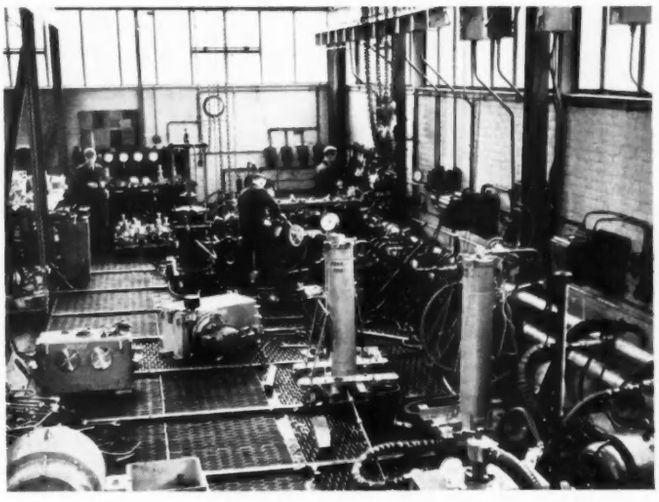
Precision finishes are important on many Towler components, and lapping is practised extensively.

Valve spindles, which are of nitralloy steel, are turned, ground to + 0·005 in + 0·003 in and then nitrided. A further grinding follows and the spindles are finally hand lapped to a surface finish of 4 micro inches. A batch of spindles is then matched by selection to a batch of valve bodies, to give a working clearance of 0·0001 in to 0·0002 in. The diameters are etched on the bodies and spindles, so that spare parts can be ordered at any time from Rodley stock.

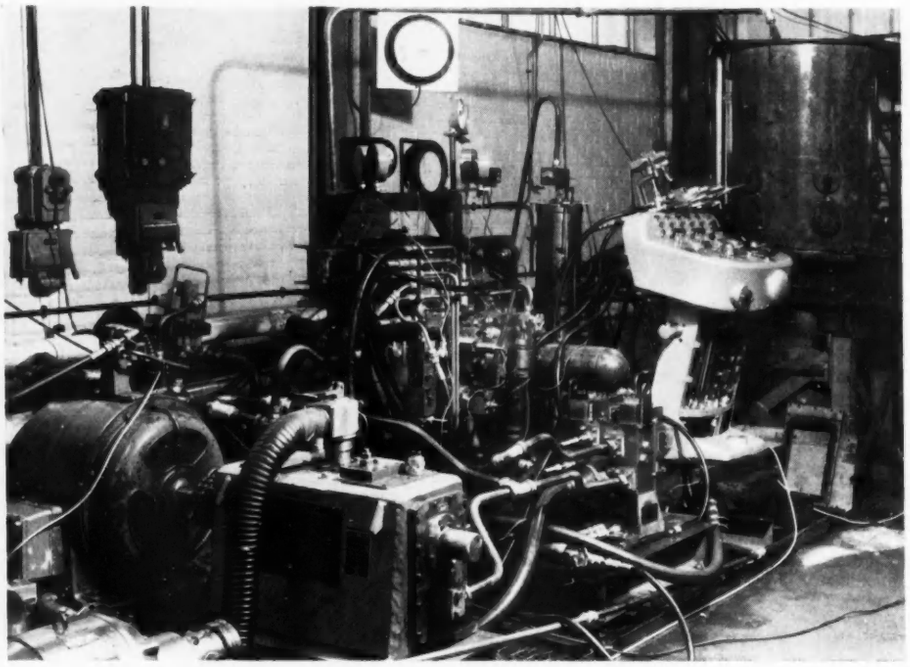
OPERATOR RESPONSIBILITY

Similar manufacturing methods and limits are applied to all other components operating under the same conditions, and individual operators are responsible for seeing that the set limits are maintained; there is no floor inspection in the normal way. Consequently, the proportion of skilled workers employed at Rodley is much higher than in many engineering shops.

Nevertheless, inspection plays a very important part in the production of Towler products. The inspection department supplies and checks the gauging and inspection equipment used in the production departments and usually checks the first component of any batch. Inspectors are always available to advise or assist if an operator has any doubts about the way his work is going. This facility is well used, and close cooperation between the two departments has kept the total



Testing facilities are provided to enable any product to be tested under full operating conditions.



Testing often requires a complicated temporary rig, as on this hydraulic pump, valve station and control desk for a hydraulic forging press.

scrap production figure of the works to less than 1 per cent.

Acceptance of components into stores ready for issue to the assembly shop is on a 100 per cent basis, and this applies to bought-out material as well. Experience has shown, for example, that even bolts, studs and set pins can be troublesome if they are not to the tolerances specified; hydraulic pressures of several thousand lb per sq. in find out many faults. Examination of highly stressed parts by magnetic and "Ardrox" powder methods of crack detection has also proved to be of great value. Similarly, non-destructive testing is applied to certain bought-out parts. An example is provided by the use of a Kelvin Hughes ultrasonic crack detector on valve manifold blocks. To avoid the use of large numbers of pipe connections in a small space, pipe runs for valves and controls are often drilled into a solid steel block. Complicated internal passages are thus produced which give a pipe run free from any possibility of leakage—unless the steel has internal flaws which might allow of communication between one passage and another. Examination of the blocks by ultrasonic means has sometimes saved many hours of wasted machining time.

ASSEMBLY AND TESTING

Components are supplied to the assembly shop, inspected and passed for limits, and matched or paired where necessary, so that all that remains to be done is to assemble and adjust. Fitting, in the proper sense of the term, is not only unnecessary but is also forbidden. If two components failed to go together in the proper way, there would have been some failure earlier in the production process, and the matter would have to be investigated. Control of manufacture is so rigid that such an event is unlikely to occur. Nevertheless, although the assembly shop is concerned, essentially, with putting components together, the workers have to be rather more versatile than in a routine assembly shop where the work is broken down into simple units. At Rodley one man assembles one pump, valve or packaged power unit, and since customers' requirements vary so much, the number of different finished products coming out of the shop at any one time is considerable.

Final assembly is controlled as rigidly as component manufacture, and every product, simple or complex, is tested fully to see that it does exactly what the specification lays down. A large test area occupies the whole width of the assembly shop at one end, and here pumps are run and tested for rate of delivery and volumetric efficiency, and valves are checked for direction and control of flow, oil tightness under pressure and any special features they may possess.

Control desks, packaged power units and valve stations are tested under simulated working conditions; very large and complicated rigs are often necessary for this purpose.

MELTING IN A VACUUM

Alloy Steels with Minimum Contamination

SOME metals are so sensitive to contamination by atmospheric gases when hot that they can only be melted under conditions which prevent air from reaching them. Titanium and zirconium are well-known in this respect. The technique necessary for melting these metals, however, is also applicable to others which, while they do not have to be given such treatment, can benefit by it. High grade alloy steels are a case in point. Experiments have shown that many existing alloy steels can be improved by melting under air-free conditions and that new alloys are possible which could not be made by any other method.

Melting under air-free conditions is possible in one of two ways, in an inert atmosphere or in a vacuum. The latter melting process, which itself can be divided into two types, consumable-arc and induction, was pioneered in this country by William Jessop and Sons Limited, now united with their associated Company under the joint title of Jessop-Saville Limited, Brightside, Sheffield, 9. Equipment for vacuum melting by both methods is now in operation at Brightside, and titanium, zirconium and alloy steel ingots are in regular production.

Starting with titanium in 1956, Jessop-Saville developed consumable-arc furnaces capable of producing ingots up to 20 in diameter and 1 ton in weight, and at the same time carried out extensive research work on steel melting, both in the consumable-arc furnace and in a small 20 lb vacuum induction furnace. Much interesting information has been disclosed as a result of the work done on alloy steel. It has been shown that vacuum melted steel is particularly good in the matter of freedom from non-metallic inclusions, a vital consideration in steel for such components as gas turbine and compressor discs and ball and roller bearing races, to cite only two examples. Vacuum melting reduces the total gas content of the metal. Tests have shown that remelting of air-melted steel in vacuum reduces the total oxygen, hydrogen and nitrogen content of the steel from 600 parts per million to 200 parts per million or less. Tensile tests of vacuum melted 12 per cent chromium steel have given elongation values four times greater than those obtained on conventionally-melted material.

Vacuum melted steel has in addition proved very acceptable for use on some components which are not highly stressed. Users of steel for plastic moulds, for example, have found that the freedom resulting from vacuum melting is of great value, since there is no risk of finding an inclusion after a lot of expensive machining has been done and a mould is nearly at finished size, when it would be too late for rectification.

The success of the vacuum melting technique soon made it obvious that the plant available at Brightside would be insufficient to meet demands, and two new furnaces, one of the consumable-arc type and the other an induction furnace in a fully evacuated chamber, were therefore ordered. These have now come into full production.

Of similar type to others already in use by Jessop-Saville, but much larger, the latest consumable-arc furnace was built by W. C. Heraeus, GmbH, Hanau, Germany. It consists of a large vacuum-tight vessel evacuated by pumps which are capable of handling large volumes of gas at high vacuum. A water-cooled copper crucible forms the lower half of the furnace and it is here that the actual melting takes place. An electrode formed of the metal to be melted is held inside the crucible by a feeder rod, to which it is end welded, and which projects through a vacuum seal to an automatically-controlled drive mechanism.

The melt is started by striking an arc between the end of the electrode and a small charge in the bottom of the crucible, and as the melt proceeds the metal builds up into an ingot inside the crucible, solidifying under the influence of cooling water circulated round the sides and bottom of the crucible.

A remote control desk and automatic control of the vacuum equipment enable the melt to be carried out under finely controlled conditions. A current of 18,000 amperes can be applied to the electrode.

Two pumps deal with the evacuation of the furnace, one of the Root's type and the other a booster pump. Their combined speeds are 4,000 litres per sec for air and 10,000 litres per sec for hydrogen. They will hold the melting pressure to less than 1 micron of mercury.

Titanium ingots from 9 in diameter and 120 to 140 lb in weight through sizes 12, 16 and 20 in diameter to over 2½ tons in weight are made.

and zirconium ingots can also be produced. Steel ingots up to about 3 tons in weight can be made in the same range of sizes as the titanium ingots.

VACUUM INDUCTION MELTING

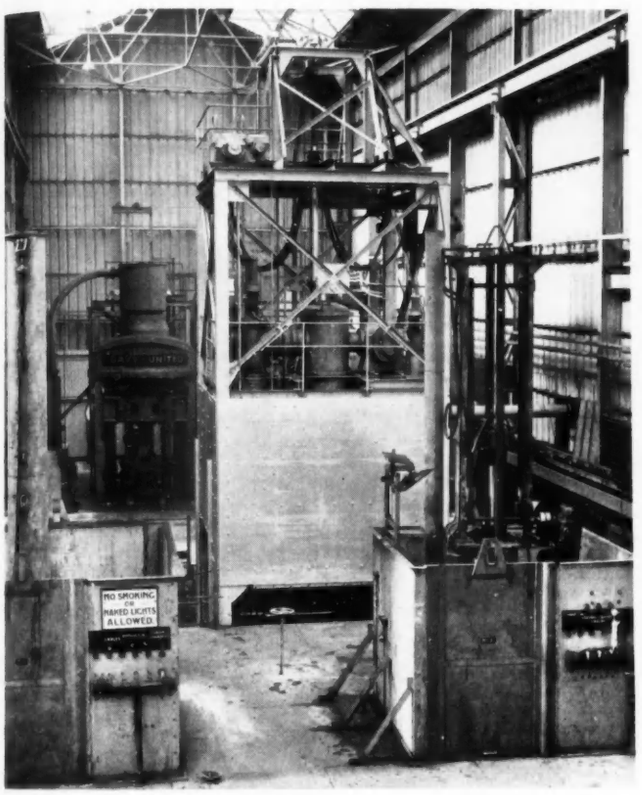
The induction furnace is designed for semi-continuous working, being equipped with a rotary mould table capable of carrying several ingot moulds, and a charging hopper through which the furnace can be charged without breaking the vacuum. It is of Wild-Barfield manufacture, to designs by the National Research Corporation of the United States, and takes a charge of 600 lb.

A stainless steel horizontal vacuum chamber 7½ ft diameter and 9 ft long, with a hinged door, and external water cooling contains the melting unit. The latter is of the normal type, supplied with 400 V, 3,000 cycles/sec current from a 200 kW motor alternator set. Vacuum equipment capable of dealing with the gases from a 600 lb charge comprises a 16 in diameter high vacuum manifold and a 6 in diameter rough pumping line connected to the end face of the chamber. The combined vacuum pumps will reduce the furnace chamber pressure from atmospheric to one micron of mercury in 15 minutes.

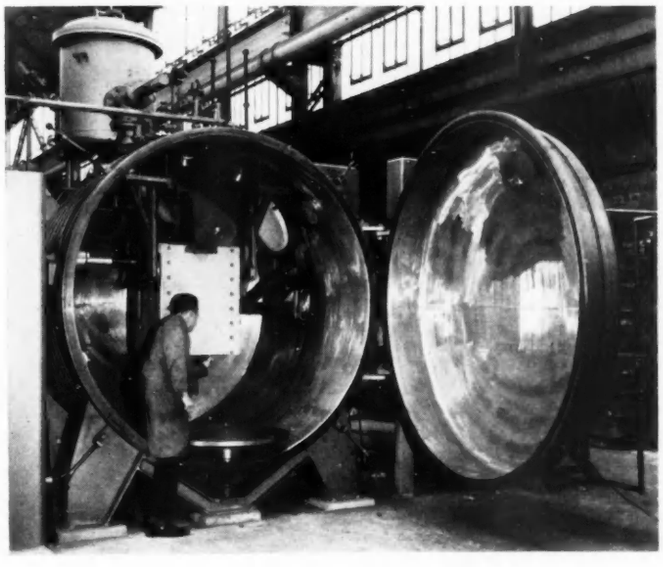
An operating platform, with controls for the electrical and vacuum pumping systems is provided on the side of the furnace chamber, and provision is made for viewing the progress of the melt through three observation windows; an internal light assembly is provided to illuminate the interior.

External controls are provided for: breaking the top layer of unmolten metal in the crucible, temperature measurement, sampling of the molten metal, and the introduction of the charge and alloying materials without breaking the vacuum. Temperature measurement is by immersion pyrometer, externally controlled, and by optical pyrometer through a sighting tube.

A cylindrical chamber, mounted on top of the melting chamber, contains the alloy charging mechanism, a 2,200 cu. in bulk charging hopper holding 300 lb of material, and four smaller hoppers each of 90 cu. in or 12 lb capacity each. Bulk charge and alloy ing materials are all delivered to the crucible by a vibrating feeder through a 6 in diameter vacuum lock. External controls enable the crucible to be tilted about its lip for teeming into ingot moulds carried on the power-rotated turntable, so that the whole process of melting and casting occurs in a vacuum.



Heraeus consumable-arc vacuum melting furnace, for titanium, zirconium or steel, at Jessop-Saville Limited.



Wild-Barfield—NRC vacuum induction furnace with equipment for casting as well as melting under vacuum.

Marketing

Promotion of Ships

The British shipbuilding industry is becoming sales conscious as never before. A poster illustrating the types of ships built in the United Kingdom has been prepared as a cooperative effort by the Shipbuilding Conference and is now on exhibition in many railway stations and in shipyards, engineering works, and ship-repairing establishments all over the country.

The poster, which is the first ever produced by the industry, depicts a colourful procession of 24 ships ranging in types from the passenger liner and large tanker to the smallest craft. It is intended to make it available to technical colleges and schools, along with a leaflet describing the type and dimensions of each ship, the builders, and the owners. But the primary object is to give widespread distribution abroad, in the appropriate languages, and this is being done with the cooperation of the Central Office of Information.

Sound Tracks

British films about British industry have achieved considerable success recently. They have grown in number and quality, as was shown at the Festival of Films in the Service of Industry held last week at Harrogate. More than 250 films were entered in 11 different categories. Among the winning entries were "The Travel Game," in the section entitled public relations for general audiences (by British Transport Films for the British Transport Commission), "The Glass Makers," in the section for specialist audiences (by Cecil Musk Productions in association with the Film Producers' Guild for Pilkington Brothers) and "Catalytic Reforming—the Reforming Reaction," in the section background and training within industry by Merton Park Productions Limited, in association with the Film Producers' Guild for British Petroleum Company Limited.

British industrial films also did well at the fifth International Advertising Film Festival in Venice last September. Advertising films were entered by the Film Producers' Guild which won the Venice cup and a special cup awarded for the producer with the highest average marks for a minimum of six advertising films entered. These were "Want to Make Your Fortune?" for Barclays Bank DCO, "Dream Sound," "Rough Running," "Fussyman," and "Poserman" for the Shell Petroleum Company, and "Na, Him be the Best" for the Cement Marketing Company. In the 56 to 110 metre cartoon category "Want to Make Your Fortune?" won First Prize and "Dream Sound" an Honourable Mention. Two of the films were made by the Guild Television Service and four by the Larkins Studio. All six were cartoons. An article on the Festival is included in the spring number of *Imagery*, the magazine of the Film Producers' Guild, together with articles on a film tribute to the car racing ace Juan Fangio, sponsored by British Petroleum, and on the Jet Provost air trainer, made for Hunting Aircraft.

Compressors for China

A technical leaflet illustrating a mobile compressor, printed in Chinese, was used to support an extensive mailing campaign to China and Chinese speaking communities. The compressor is the Mackay DAC130, which is a free piston machine manufactured at Feltham. It is refreshing to find a British firm, who are well known as the distributors of Allis Chalmers equipment, setting out to establish themselves in a market in this manner.

The pattern of the portable compressor sales has changed considerably in the past few years. In 1955, 92 per cent of all compressors sold were of the reciprocating type; in 1958 this proportion had fallen to 51½ per cent. The change was due

almost entirely to the growth in the popularity of the portable rotary type. The free piston compressor has yet to make a major impact in the British market but Mackay's vigorous promotion, both here and abroad, is expected to improve its competitive position.

Credit for Oil Plant

A company has been formed to promote schemes for the sale, on deferred terms, to overseas purchasers of capital plant and equipment made in the United Kingdom for the petroleum industry. The new company, British Oil Equipment Credits Limited, is a subsidiary of the Council of British Manufacturers of Petroleum Equipment. The chairman is Mr. E. F. E. Howard, of Hayward Tyler and Company, and the managing director is Mr. G. V. Sims, director of the CBMPE. BOEC's first job will be to arrange credit terms for the supply of British made equipment for an extension to the Minatitlan Refinery in Mexico, and Mr. Sims has left for that country.

This appears to be a novel approach to the growing need to provide deferred terms for the purchase of capital plant. It has become quite plain over the past year or so that our foreign competitors, particularly the United States, West Germany and Soviet Russia, are determined to make it easy for under developed countries to buy their capital goods. This is now a recognised and most effective method of winning friends and influencing people and the time cannot be far off when all heavy plant and machinery exported will be paid for on an "as-it-earns" basis. The CBMPE have shown that it can be done on a cooperative industry-wide basis.

Dealer in Aircraft

The world's largest deal in secondhand aircraft was concluded recently between American Airlines and Frederick B. Ayer and Associates. Ayer contracted to purchase 45 Douglas DC-6 aircraft from American Airlines, as they became available. They also negotiated the right of first refusal for the purchase of the remaining 36 DC-6 series in AA's fleet. In all, Ayer and Associates have bought 80 aircraft since last September, valued at $40·5 million.

Their 31-year-old head and founder, Mr. Frederick B. Ayer, said that he believed the sales potential of the DC-6 was "unlimited." Earlier he had purchased 30 Convair 240's and the whole of AA's surplus Convair 240 airframes, spare engines and component parts. An agreement was concluded last September with AiResearch Aviation Service Company, a division of the Garrett Corporation of Los Angeles, California, to collaborate in the production of an executive version of the Convair. Mr. Ayer obviously intends to take advantage of the current boom in the sales of personal and executive aircraft. During 1958, 6,414 aircraft were sold (according to the US Aircraft Industries Association) at a retail value of approximately $135 million, mainly secondhand machines.

Ayer's aims are to act as "a commercial aircraft center for the world's airlines by leasing planes on a short term basis, trading trade-ins, arranging finance and offering a variety of tailor-made equipment transactions. The airlines . . . could thus cut down on the costs of expensive equipping solely for peak travel periods."

At Home

WHICH REFRIGERATOR?

With the Budget news, refrigerators along with other domestic appliances will be looking to increased sales. Indeed the North Western Electricity Board report that 469 were sold during the week following the Budget announcement, as compared with 80 in the week before. It is very timely therefore that *Which*? the journal of the Consumers' Association Limited, should include an appraisal of current models of domestic refrigerators in the April edition. It is even more interesting that the revised British Standard on refrigerators should also have been at the same time.

The comments of an authoritative independent body are always appreciated both by the purchaser and the seller. While such bodies as the British Electrical Development Association ensure at their test laboratories that articles submitted to them comply with existing standards for safety and performance, they make no comment on the aspect of value-for-money or of running costs. Indeed such comment from them would be out of place.

For the ordinary consumer, however, faced with a large number of appliances which outwardly may vary very little, making a choice can be a worrying problem. It is extremely useful for him, therefore, to have an entirely objective report on the performances of apparently similar machines from which he can then select the one that most nearly meets his needs. Who would have expected, for example, that for the thirteen refrigerators tested by CA the electricity consumption per cu. ft of storage space should have varied by a factor of 13 : 1?

The new British Standard, BS 922 and 1691: 1959—"Electrical refrigerators and food freezers for household use", incorporates in one volume the two earlier Standards that dealt with the requirements for all climates and for temperate climates separately. Developments in design practice and refrigeration techniques are embodied in the revision, and the number of permissible refrigerants has been limited to those known to be satisfactory in general use. Some alterations have also been made to the methods of computation of the shelf areas and storage volumes. Details of the construction of both the cabinet and the refrigerating system are specified, and requirements for the electrical components are given. There also are production tests for each appliance as well as type tests for assessing performance.

The type tests include such proofs as shelf loading, taste contamination, and radio interference. To check the strength of the shelves, for example, they are pulled out to their farthest position (if they are moveable) and covered with weights: for taste contamination, a pat of unsalted butter is left in the refrigerator for 24 hours in an open dish, and then tasted immediately after removal.

Which? is published monthly by the Consumers Association Limited, 333 High Holborn, London, WC1; associate membership costs £1 per annum. BS 922 and 1691 is obtainable from the British Standards Institution, 2 Park Street, London, W1, price 7*s* 6*d*, and *Recommended Electrical Appliances*, List No. 7, Jan. '59, is issued by EDA, 2 Savoy Hill, London, WC2, price 2*s* 6*d*.

ROLL-UP LADDER

Ladders are usually awkward things to store around the house owing to their length. They can also be difficult to move from place to place for those not used to them.

Both points are to some extent overcome by the Easy-Roll ladders now being made by Bentall-Alley Limited, Maldon, Essex, an example of which is shown in the illustrations.

The side "rails" are made up of blocks of fir fixed on one side to a continuous backing strip. On the other side a wire is run through guides and is used to make the ladder rigid when erected. To set up a ladder, it is laid on the ground and the tie cord released. Then it is unrolled and turned over so that the wire is uppermost. At the foot of the ladder are toggle-action tensioners to which the wires are hooked and then tightened, the toggle handles finally lying flat against the rails. The ladder is now ready for use. It is important to remember, however, that there is a wrong and a right side to the ladder, which is indicated on the rungs.

There are two sizes: 10 ft, which when rolled up measures 20 in wide by 21 in diameter; and 12 ft, measuring 22 in by 23 in diameter. The longer model has a hinge at the centre by which it can be converted to a pair of steps. A platform is included that can be hooked on to the hinge and will rest on the first step.

A 10 ft ladder rolls into a bundle 21 in in diameter.

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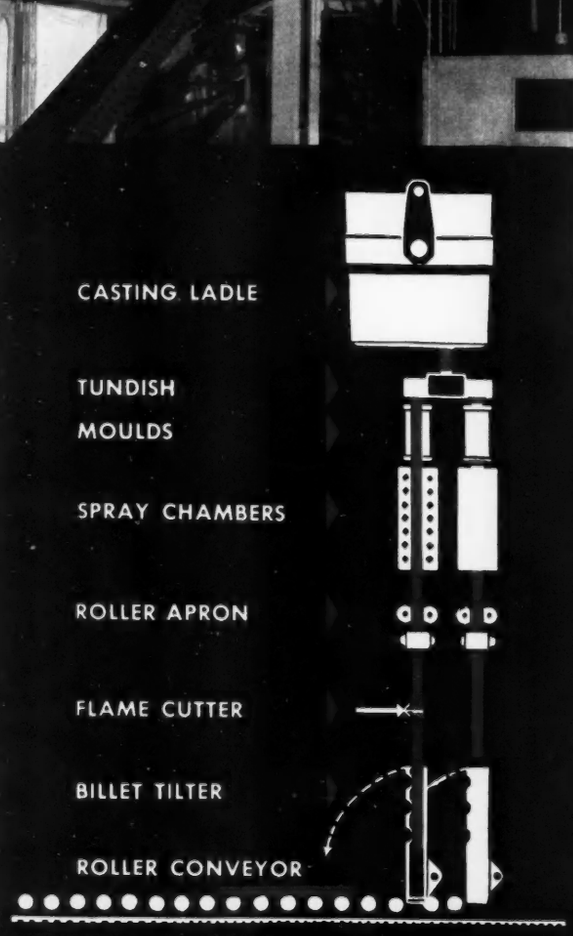

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ENGINEERING

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Contents

629 **Leading Article**
Comment is Free

630 **Plain Words**

630 **Weekly Survey**

631 **Letters to the Editor**
Tyre and Road Adhesion
Earthquake Structures
Standard Symbols

635 **In Parliament**

636 **Companies in the News**

638 **Atomic Review**
The Eight Contending Nuclear Ships

644 **Automobile Engineering**
Electronics Improve Motoring: Analogue Computers Solve Design Problems
Road Accidents: What Remedy?
No more Standard Cars?

648 **Meetings and Papers**

649 **On the Shelf**

649 **Publications**
19 Handbooks Reviewed

New Books

Trade Publications

660 **At Home**
Efficient Open Fires

. . . . . .

632 **New Plant and Equipment**
Shovel Loader, Dynamic Balancing, Electric Ovens, Grinders, Hose Coupler, Annealing Furnace, Metering Pumps, Rubber Conduit, Vibration Monitor, Screwing Machine, Flow Alarm, Low Load Trailer, Wide Belt Sanders, Mine Pump, Air Compressors, Albion Reivers, Insulation Testers

637 **The Human Element**

642 **Construction**
Low Pressure Grouting to Repair Underwater Piers
Capital works for Khuzestan
Candela's Shells

645 **Research and Development**
Blade Frequency of Turbines: Effect of Disc Elasticity
Research on Design: Defining Criteria of Taste
Fuelling Jet Airliners: Shell Research Solves Problems of Fast Flowing Fuels

651 **Metals and Materials**
Low Temperature Stress Relieving of Welded Platework
Fabrication of High Temperature Materials

653 **Design**
High Speed Counting Tube
Noise Absorbing Pyramids
Nylon Bobbins for Small Transformers
Combined Steering Controls
Hydrostatic Drives: Review of Dowty Practice
Air Travel at Mach 7: Basic Studies for a Hypersonic Aircraft
Future Demands for Aircraft Electronics

657 **Production**
Faster Steel Production: Electric Furnaces Charged with Hot Metal

659 **Operation and Maintenance**
Tracing the Source of a Leak in a Fuel Tank
Multi Facsimile Communication
Fluctuating Demand for Natural Gas

659 **Marketing**

ENGINEERING *Appointments Section faces page 644*

Comment is Free

LABOUR'S desire to extend nationalisation and develop State participation in industry is to a large extent directed at engineering industries. The machine tool and aircraft industries have been specifically mentioned by Mr. W. J. Carron, president of the Amalgamated Engineering Union. Though these far-reaching changes can only take place if the Conservative Government is displaced by the Socialists, such an election result is possible in a few months' time. What, then, are the likely consequences, and, in particular, what would be the effect on technical innovation in the future?

In endeavouring to be as unpolitical and as objective as is humanly possible, we must first declare our assumptions. Briefly, they are (1) though the issue may be clear-cut to some politicians, it is not clear-cut to anyone who is not politically or emotionally committed; (2) that we start with the fundamental aim of doing that which is best for the nation in the future (it would be laudable to say " best for mankind " but that raises too many unanswerable questions). Two essential requirements seem to follow from these assumptions: first, that Britain should continue to do business successfully with other nations, and secondly that reasonably full employment should be maintained.

The Labour Party cannot be wholly blamed for failing to give full details of their proposals, since a party has to wait until it is in power before it can work out the details of such a large plan. This much is clear, however: that Mr. Harold Wilson, the party's " shadow " Chancellor, visualises the broad lines on which a Labour Government would acquire shares in 512 large firms (of which about 200 are engineering firms); that he can also envisage cases where a company which is wholly or mainly dependent on Government contracts should be bought by the State to the extent that the Government would be justified in securing powers to buy shares direct; that full-scale nationalisation would be in addition to these plans; and that a Labour Government would take powers to place in public ownership any industry or part of industry which " after due inquiry was found to be failing the nation."

Recent history suggests that there are three kinds of background against which technical innovation can flourish. There is the old-established industry which is still developing technically (machine tools, for example); there is the entirely new major industry (nuclear engineering, for example); and there are the countless small firms (" industry" would be too large a word) which spring from the enterprise of a man with an idea who can find the money to start him off. New major industries today invariably have to be subsidised by the State, not only because of the immense cost but also because the industrial countries of the world vie with each other to lead and gain prestige. Our atomic energy programme and achievements showed that in those circumstances Government money and control can be very effectively administered.

Every year over 20,000 new companies are registered in Britain, and every year the number of companies which go out of business is about a third of that figure. It would be impossible to tell the whole fascinating tale of these successes and failures. It is the constant unseen drama of our times. It is enacted by thousands of men and women whose motives range from the altruistic to the sordid, but their customers take a severely practical view of their labours—is their product or service worth the money? If, as Mr. Tom Driberg says, this capitalism " is intrinsically immoral," surely men are immoral and the world is immoral and socialist idealism cannot make them otherwise.

What of the old-established industries which are still progressing technically? If any such industry is thought to be progressing too slowly, the machinery for giving an injection is already to hand; namely, the appropriate research association. But it is necessary to utter a warning that we cannot have all industries equally progressive at the same time; the technical opportunities vary enormously, and in general they are less with the older industries. There is, also, a limited supply of first-class engineers and scientists—and that restriction will always apply, regardless of future success in education.

Let the Government favour selected industries or projects with the hot-house of a subsidy—in one form or another—but let them leave most of the normal control and administration of industry dispersed widely throughout the nation. That way, enterprise is free and comment is free. The Government of the day should be a supreme board of directors, not an executive committee. Some one—some high-level body—must remain detached, able to encourage, guide or rebuke. If a Socialist Government came to office and acquired the powers they are now discussing, they would forego that indispensible privilege. They would become tainted with the immorality to which we are all inescapably committed.

Cover Picture.—*To make the impregnated-paper insulation on electric cables, the paper is lapped on to the conductor and then subjected to a double process. The air and moisture are first evacuated by heat and vacuum, and then the insulating compound is induced into the paper under pressure. An impregnated core is shown being lifted from the process vessel.*

(*Nurnberg photograph for* ENGINEERING)

Plain Words

Slumming after my visit to the Royal Academy's private view last week, I recently took a stroll through the Embankment Gardens, where in the summertime all sorts and conditions of painters exhibit their works in the hope of a ready sale. In my superior way, I felt very disappointed, for I saw only two or three pictures that showed any sign of a unique human personality. As at the Royal Academy (where at least the lush competence of sunlit Riviera scenes and the pore-by-pore depiction of celebrated men gave evidence of some professional skill), the only approach to an individual vision was the deliberate and self-conscious choice of a particular range of colours combined with a recognisably constant pattern of shapes. It suddenly struck me that what distinguished the great painters—the Titians the Michelangelos, the Rembrandts, the Cezannes, Matisses and Picassos—lay not merely in recognisability (certainly their works are recognisable; take van Gogh's for instance), but in recognisable purposeful work. The distinction seemed to lie in the difference between recognisable style, which most of us can achieve, and recognisable quality, which is achieved by few.

Nowadays, we spend a lot of time creating personality. Public relations men mould pop singers and film stars in the ideal public image; we establish in the structure of our offices and the pattern of our notepaper the characters of our companies; we are so determined to have distinguishable bodies for our cars that we have foreigners design them—with the result that they can scarcely be distinguished. The trouble, it seems to me, is that we have discovered how easy it is to have a personal style, but not yet how difficult it is to have a personal quality.

We are being seduced by fashion away from character. Nowadays we are very much the creatures of the world we live in and the companies we work for. Once the master of a company made it what he wanted; today it is the company that moulds its masters. We are like Harry Lyme's version of the Swiss: after 500 years of civilisation, what did they produce? The cuckoo clock. (Since then, incidentally, they seem to have made up for it.)

Quality, unlike style, is a function of the work content, either in the doing or the having done. What Picasso can do now is the swift delight of a practised hand and a history of struggling to interpret. We would rather, and often think we can, do it the easy way. But all we achieve is style without significance.

CAPRICORN

Weekly Survey

Nuclear Ship Proposals

Although it may be some time before the first British nuclear-powered merchant ship is commissioned, the Admiralty announced last week that seven plans have been submitted representing an important step forward. As a touchstone for the others, the UKAEA also described a ship propulsion unit based on the Advanced Gas Cooled Reactor now building at Windscale. The various systems proposed will have to be examined for safety by the Atomic Energy Authority and the Ministry of Transport and Civil Aviation, and each proposal will be assessed by a technical subcommittee to be set up by the Civil Lords Committee, which will simultaneously examine ways of financing the first ship. The Admiralty have stated that their goal is the economic nuclear merchant ship.

The diversity of the proposals submitted was shown when papers on the eight systems were read last week. The Atomic Energy Authority proposed the advanced gas cooled reactor system; AEI—John Thompson Nuclear Energy Company put forward a direct-cycle natural-circulation boiling-water reactor system; Babcock and Wilcox a pressurised water reactor system; de Havilland Engine Company, the high-temperature gas-cooled reactor system; GEC—Simon-Carves, the gas-cooled graphite-moderated reactor system; the Hawker Siddeley Nuclear Power Company, the organic liquid moderated reactor; the Mitchell Engineering—Fairfield Shipbuilding and Engineering Company group, a closed cycle boiling water reactor system and Vickers Nuclear Engineering, a steam-cooled heavy-water reactor system.

There are considerable differences in the dates at which the various systems could be made available. Some firms undertake construction at a firm price, while delivery periods as short as 30 months have been quoted. (See Atomic Review.)

The Coal is Not for Burning

The rapid accumulation of stocks of coal is underlining the importance of developing as a matter of urgency all possible methods of converting coal into chemicals, gas and oil. Further closures of coal mines would create a major social problem and both the board and the Government would be most reluctant to take this course.

For some time now there has been criticism of the slow progress in by-product research. The Ministry of Power has been solely responsible for all research and development work so far and has carried out a research and development programme in conjunction with other Government departments and outside interests. The Minister has now decided after consultation with Sir Alexander Fleck, chairman of his Scientific Advisory Council, to set up a committee with the following terms of reference: "To review the work that has been done in recent years on the development of processes in which coal is the basic raw material and which will produce marketable products of a chemical or a gaseous or liquid hydrocarbon type; and to make recommendations as to the direction of further research and development work on any such processes which appear to the committee to hold promise of industrial application, and as to the type of organisation or organisations best suited to carry out such work". The committee will be wholly independent, with Mr. A. H. Wilson, F.R.S., as chairman and a membership drawn from leading industrial scientists.

The Ministry of Power will continue its work, and contracting organisations are assisting by providing technical and cost data. Experimental and development work is being carried out on behalf of the ministry in the laboratories of the DSIR, BCURA, and by contractors. The National Coal Board have, for their part, set up a new department, the Process Development Department, "to take charge of the development of new processes for treating coal and in particular of the development of new processes for making smokeless briquettes from small coal. Dr. J. Bronowski, who was director of the board's Coal Research Establishment at Stoke Orchard, has been appointed director-general. The department will come within the field of responsibility of Mr. A. H. A. Wynn, the board member for science and carbonisation. These steps are a welcome if belated effort to win for the coal industry a leading position as a source of chemicals and hydrocarbons in a field which so far has been left almost entirely to the oil companies.

Coal and Its Competitors

Before the end of April, United Kingdom coal stocks had exceeded the level of 22 million tons, which the National Coal Board estimated last November would be the ceiling figure for stocks. In recent weeks the figure has been increasing by about half a million tons per week and a further rise during the summer months appears inevitable. In the House of Commons debate on 4 May, considerable anxiety was expressed regarding the future of the industry and the danger of increasing reliance on imported oil fuels.

The main problem facing the industry is to estimate how far the present recession in demand is of a temporary nature due to lack of industrial expansion and how far it represents a long term shift to other forms of fuel including oil and nuclear energy. Opposition arguments that oil imports should be restricted by taxation or other means were rightly rejected by the Government on the grounds that this must lead to increased costs to industry at a time when manufacturing costs must be prevented from rising if exports of manufactured goods are to be expanded. After a prolonged period during which the coal industry was unable to meet the full demand, some recession in consumption is welcome, since it makes possible the closing of high cost pits and should thus in the long run improve the competitive position of the industry. An encouraging feature of the debate was the statement by the Paymaster General that for the first time in many years coal production costs have in recent months been falling. But if the policy of pit closure is carried too far, it may well prove difficult to expand output when industrial demand again increases.

The gas industry in particular was criticised for its policy of importing methane and it was suggested that this might lead eventually to a further fall of some 13 million tons per annum in the demand for coal. Serious as this would be for those pits producing gas coal, it is difficult to escape the conclusion that if the economies expected from the experimental shipment of methane are in fact achieved, they will offer important advantages to industrial users of gas, many of whom would otherwise be at a serious disadvantage compared with their competitors abroad.

Gas Resources Redeployed

In the past ten years the consumption of gas in all European countries increased by about 35 per cent. The gasworks were able to cope with this increase by purchases from outside of coke-oven gas, natural gas and refinery gas. These outside

sources are now becoming so important that in some countries the traditional gas producers are increasingly assuming the role of distributors. This information is given in the third volume of the *Annual Bulletin of Gas Statistics for Europe* for 1957, recently published by the Economic Commission for Europe.

For the first time the Bulletin has tables showing the production, consumption and sale of blast furnace gas. The gas industries of the various countries are stated to be contributing 5·5 per cent to the energy balance of Europe, and 7·2 per cent to that of the USSR. These are very small percentages but the report shows that the gas industry's contribution is expected to go on rising thanks to increased use of natural gas.

Although the increase in the use of gas over the past two years has been greater than that for all forms of energy, it must be remembered that the Suez crisis occurred during this period. The product of natural gas in Europe between 1955 and 1957 rose by 34 per cent. The biggest increase was in France where the development of the Lacq deposits began. Italy and the Netherlands both showed considerably increased production. In Eastern Europe the biggest advances were made by Rumania. In Poland, the other major producer, output fell by 5 per cent in 1957. The Bulletin is highly optimistic about the future prospects for natural gas.

Oil Thirsty Britain

The United Kingdom Petroleum Industry; Statistics Relating to Consumption and Refinery Production 1957 and 1958, published last week by the Petroleum Information Bureau, show that oil consumption increased by 25·3 per cent in 1958 compared with 1957. Deliveries in the latter year were, of course, reduced as a result of the Suez crisis but the increase in 1958 as compared with 1956 was 23·2 per cent, a remarkable figure in view of the general stagnation in industrial activity over the three years.

Comparing 1958 with 1957, a major part of the increase was accounted for by gas, diesel and fuel oils, of which consumption (excluding consumption at refineries) rose from 9·3 to 13·7 million tons, a rise of 47 per cent. Consumption of fuel oil alone rose by 52·7 per cent and of gas and diesel oil by 27·6 per cent. Kerosine (burning oil) which has not hitherto been one of the major products, showed a considerable rise in consumption from 0·8 million tons in 1957 to 1·1 million tons in 1958. This is ascribed mainly to a marked increase in the number of portable domestic space heaters in use, of which the total is thought to be between 8 and 9 million.

The statistics include an analysis of deliveries of the principal products by end use. In 1958, steam raising accounted for 5·4 million tons of gas, diesel and fuel oils, of which electricity generation took 2·6 million tons compared with only 0·6 million tons in 1957. Another major increase in this field was in the consumption for central heating of premises other than private houses, which rose from 1·2 to 1·8 million tons.

Deliveries of motor spirit at 6·6 million tons were 15·3 per cent higher than in 1957 but only 4·7 per cent above the 1956 figure. The major increase in this field was, of course, in consumption by cars and motor cycles which rose from 3·0 million tons in 1957 to 3·6 million tons in 1958. Somewhat surprisingly the consumption of motor spirit by industrial vehicles rose from 1·8 to 2·1 million tons and was still in 1958 nearly twice the consumption of derv fuel, which amounted to 1·2 million tons.

How to Export

Guidance to individual firms on how they might increase their exports is contained in a booklet entitled *A Survey of Export Trade Facilities* published recently by the Federation of British Industries. The booklet is the product of investigations carried out by the working party on export trade facilities appointed by the federation last year "to survey broadly the facilities available for assisting firms in the development of their export trade with a view to identifying any gaps, for example, in education and training facilities for sales and other staff, and to recommend any necessary action." The working party's chairman was Sir Cecil Weir, chairman of International Computers and Tabulators, and members included representatives of trade associations and other corporate bodies such as the British Electrical and Allied Manufacturers' Association, the Association of British Chemical Manufacturers, the National Union of Manufacturers, the Incorporated Sales Managers Association, the Scottish Council, the Institute of Export, the Association of British Chambers of Commerce and of some of the leading export companies. Witnesses were called from other organisations and various submissions of experts in the export field were considered by the working party.

The result is as useful a guide to successful exporting as has yet been published. The background against which the work was done is one of much improved performance—17 per cent of the country's gross national product was exported in 1957 compared with 9 per cent in 1938—but nonetheless less successful than that of our foreign competitors: in 1938 Britain accounted for 22·1 per cent of world exports of manufactured goods; in 1957 this share had been reduced to 18·1 per cent.

The report's main recommendations fall under three broad headings: education and training, market investigations and trade promotion. The working party were impressed by the very small amount of special education and training given to export salesmen and recommend a considerable extension of training facilities including the use of sales-training films. Market research and a fuller use of existing sources of information is also strongly recommended. In the field of sales promotion overseas design and packaging, advertising, trade fairs and exhibitions and more official publicity were the subject of special recommendations. It is suggested that the Government should play a bigger part in assisting and coordinating the efforts of industry.

Hiring Machines Without Deposit

Ordinary hire purchase and deferred payment schemes have become increasingly popular for buying machinery in the last 20 years. A wide range of equipment has been made available to industrial buyers on terms which involved a gradual call upon cash which can often be made from turnover with a minimum call on liquid capital. In these matters this country is usually slower to develop than the United States or some Western European countries. Recently when a delegation from United Kingdom hire purchase finance houses met representatives of continental institutions engaged in the same line of business they discovered that the granting of credit lines to approved customers has developed extensively on the Continent, especially for buying durable consumer goods including cars.

A recent machine hire plan started in this country requires no deposit or capital expenditure. This is called the FJE machine hire plan (after F. J. Edwards Limited, its sponsors). The scheme covers a wide range of machinery, either new or secondhand. There is a rental arrangement for a minimum period of three years with the option to renew or take out a new agreement on expiry. Hiring arrangements have a large convenience element so far as the customer is concerned especially if they have a maintenance arrangement, but the effective rate of interest is fairly high. On the other hand, it is claimed that hire charges are deductable for income tax purposes.

Letters to the Editor

TYRE AND ROAD ADHESION

SIR, I wish to make the following few observations on the article entitled "Friction Between Tyre and Road," by Dr. D. Tabor, published on page 838 of your issue of 26 December, 1958.

Dr. Tabor's experiments of dry friction of steel on rubber are not quite in agreement with those of Schallmach (*Proc.*, Phy. Soc., London, 1952, vol. B 65, p. 657). Though the discrepancy is not much, it may need some explanation. In my view, it may perhaps be the differing loading conditions as well as the difference in the quality of the specimens existing in the two cases. Then, Dr. Tabor's results on lubricated friction (boundary lubrication) between steel and rubber are noteworthy in the sense that they are not in line with those of dry friction, and, in neither case, is Amonton's law obeyed. It is surprising that when Dr. Tabor himself did not expect such results (results not in line with those of dry friction) as he says, yet, he prescribed them as a general case for all well-lubricated surfaces. It is well known that most metals in the case of boundary lubrication obey Amonton's law (in line with the dry friction) for a wide range of loads. In my opinion, Dr. Tabor's results may perhaps be peculiar to rubber and rubber-like substances which generally give friction under lubrication, mostly due to ploughing rather than adhesion.

Lastly, I feel, Dr. Tabor's evidence on the comparison between lubricated sliding friction and rolling friction may not be conclusive. In actual practice, the load dependence in the two cases may be very different, and this might have been shown if Dr. Tabor had obtained a little more data for his Table I. From this table, it is found that both the rolling and sliding friction change inversely with steel ball diameter. For rolling friction it is right as the classical theory would show but for the sliding friction, this appears to be something new and needs explanation.

Yours faithfully, H. P. BHATTACHARYYA.
Defence Science Laboratory,
NPL Buildings, New Delhi, India.
29 April, 1959.

EARTHQUAKE STRUCTURES

SIR, I thank Mr. Sibson for drawing attention to the errors in the presentation of the initial equations in my article on "Structures to Withstand Earthquakes" (ENGNG, 13 Mar. '59, p. 346).

Equation 1 should read

$$m\,(\ddot{x} - \ddot{x}_g) + a\,(\dot{x} - \dot{x}_g) + k\,(x - x_g) = -\,m\,\ddot{x}_g$$

while the equation beneath the circuit diagram should read

$$L\,\ddot{q} + R\,\dot{q} + \frac{1}{c}\,q = E$$

where q represents the charge on the condenser, L the inductance of the coil, R the resistance, C the capacity of the condenser, and E the applied electromotive force.

The arrow on the circuit diagram, suggesting that q is a current, is misleading and should be ignored.

Yours faithfully, D. A. HOWELLS.
63 Victoria Drive, London, SW19.
3 May, 1959.

STANDARD SYMBOLS

SIR, Your correspondent, Professor James Small (ENGNG, 1 May, p. 567), has perhaps overlooked the existence of British Standard No. 1991, Part I: 1954, *Letter Symbols, Signs and Abbreviations*, which was prepared with the assistance of an impressive number of institutions and organisations. The recommendation for his example of pounds per square inch is lb/in^2, or possibly lb/sq. in; a full stop after the abbreviation for inch being permissible if the sentence would otherwise be confused in meaning. True, many of the recommended symbols in this Standard are in italic, but for hand-written use it is

SHOVEL LOADER

Front Cab for Visibility

A MAIN feature of the Frontloader 59 is the driving cab at the front of the machine, giving the driver a direct view of the bucket, as well as all-round visibility.

The cab is formed of heavy gauge steel sheet with very large toughened glass windows. The whole rear section of the cab slides backwards to give access from either side of the machine, and a large ventilator is fitted to ensure comfortable operating conditions in hot weather.

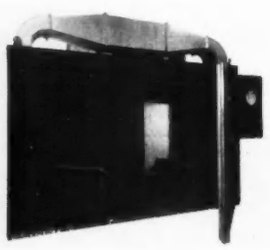
The hydraulic linkage gives a loading height (under the lip of the tipped bucket) of 10 ft 6 in or 12 ft under the hinge pin. At this maximum discharge height there is a forward reach of 2 ft. The standard bucket is of 1 cu. yd capacity and the payload is 2,800 lb. Other sizes of bucket can be fitted for special materials.

The steering system uses a heavy duty Marles cam and double roller steering gear. The large diameter steering wheels have an overall width of 5 ft 8 in and a turning circle of only 33 ft. The Frontloader is driven by the Fordson four cylinder four stroke engine giving 54 b.h.p. at 1,800 r.p.m. The drive is transmitted to the rear wheels through a 13 in Borg and Beck extra heavy duty clutch (with provision for external lubrication) and a transmission which gives six forward and two reverse speeds, up to 12·45 m.p.h. and 4·75 m.p.h. respectively.

Additional equipment includes a bulldozer blade, and crane and fork lift attachments. Also available is a Holman two-tool compressor unit which can be fitted within the wheelbase of the machine beneath the rear canopy. *Merton Engineering Company Limited, Faggs Road, Feltham, Middlesex.*

ELECTRIC OVENS

Large Capacity, External Fan and Heater



THE design of oven having the fan and heater unit external is normally used when the internal dimensions exceed 6 ft high by 6 ft wide by 8 ft deep.

The oven body is constructed of standard insulating panels, each panel comprising a welded angle- or channel-iron frame, lined with heavy gauge mild steel sheet and filled with glass wool insulation. These panels are bolted together to form the walls and roof of the oven, and they are designed to carry the fan and heater unit.

The fan and heater battery are mounted on the oven roof, where they are both readily accessible for maintenance. Removable inconel sheathed elements are banked and housed in the heater battery, which is protected against overheating by an excess temperature control; several heater units are provided each with a separate fan and individual temperature control.

The heated air is carried into the oven through supply ducts, which branch out into distribution ducts at floor level. Exhaust ducting at roof level carries the air back to the fan inlet. A series of adjustable slides in the duct work give uniform air airflow and even temperature distribution. If required, damper control can be fitted to allow either partial or complete circulation of fresh air.

The control gear is housed in a separate control box, which can be mounted on or away from the oven to suit convenience of operation. The temperature variation throughout the oven is normally within $\pm$ 2 per cent of the working temperature, but closer control can be obtained if required. *Hedin Limited, Commerce Estate, South Woodford, London, E18.*

Concluding Letters to the Editor

customary to indicate italic quite simply by underlining. I leave myself open to correction here for I cannot quickly trace if this underlining usage has the sanction of a Standard. Nor have I any recent experience on the blackboard, but a short line under the necessary letters would appear to be easy enough, if tiresome to do too often.

Of course it is one thing to prepare a Standard and another to get people to adopt it. It is perhaps too late to get many engineers to change their habits in this small matter, but it is, I submit, a matter where the educational authorities could help. Universities, colleges of technology, and senior science forms have many other matters to worry about, but correct abbreviation, as part of the art of technical writing, would probably only take half an hour to expound at the most and followed up by an occasional correction of deviations would put the coming generation on the right road and make the life of those who have to deal with paper work in times to come just a little easier.

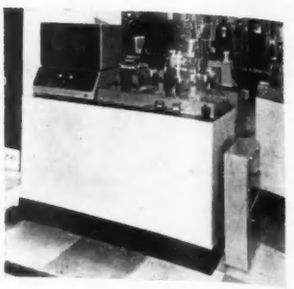
Yours faithfully, P. M. KALLA-BISHOP.

4 Temple Fortune Court, London, NW11.

2 May, 1959.

DYNAMIC BALANCER

No Mechanical Drive



THE Electrodynamic balancing machine type R06 has been designed for balancing rotors of small electric motors using a drive without mechanical connection.

Beneath the rotor mounting supports is a wound stator coil, open at the top, which provides a magnetic field sufficient to rotate the rotor at high speed. Advantages are the speed of loading and unloading and the ability of the machine to balance rotors that do not offer a surface suitable for a driving belt. A mark on the rotor triggers the time base of the recorder to define the angular position of the unbalance. (In the illustration a belt drive unit is shown on the right.)

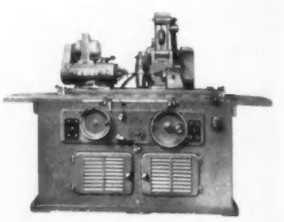
The measuring range of the R06 is for rotors from 0·03 kg to 3 kg (6·6 lb approximately), and up to 350 mm in diameter; the maximum distance between bearings is also 350 mm. Balancing speeds are from 900 to 30,000 r.p.m.

The two bearing pedestals each contain a bearing bridge supported on springs; a rotor bearing with roller and plastics inserts, adjustable for journals between 2 and 10 mm in diameter; an electrodynamic vibration pick-up; and a locking device.

The degree and position of unbalance is shown on the indicator unit by the vector meters. The unit also includes potentiometers to set indication on gram-unbalance or drilling depth. The driving coil is fed from a frequency convertor (50 to 100 c/s) and a single coil will serve for a variety of rotors. *W. and T. Avery Limited, Birmingham 40.*

GRINDERS

Plain and Universal Machines



TWO grinders for the production shop and toolroom are the U.G.1 Universal and the P.G.1 Plain cylindrical machines. Both are capable of producing a surface finish of 2 micro-inches.

Both machines are hydraulically controlled throughout and the table traverse has an infinitely variable speed. The hand-traversing unit is automatically engaged when the table is not under power. The wheelhead on each machine can be rapidly advanced and withdrawn with exact repetition of movement and the provision of an automatic "knock-off" arrangement allows final sizing by hand.

On each machine, the external grinding wheel is fed in by a hydraulic cross feed unit or by manual operation, with micrometer feed in divisions of 0·0001 in. Automatic in-feed at every pass may be set to any increment of 0·0001 in to 0·0012 in (0·0002 in to 0·0025 in measured on work diameter). The hydraulic cross feed unit has fully-enclosed mechanism. On either machine, the wheel spindle can be fitted with precision taper roller bearings or with plain bearings.

Both machines are suitable for live and dead centre grinding. For taper grinding, on both machines, the worktable can be rotated 7° in either direction and indexed at 1° intervals.

In the U.G.1, the workhead swivels through an angle of 110° and the wheelhead through an angle of 120°, and on the same machine the change-over from external to internal grinding is a quick and simple operation. A micro-switch automatically reverses the spindle motor to bring in the correct rotation of drive. *British Northrop Limited, Blackburn, Lancashire.*

HOSE COUPLER

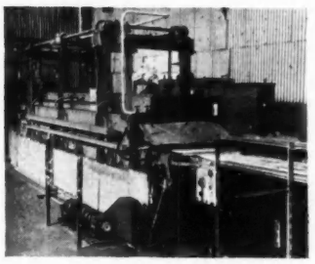
Quick Action Wide Bore

TO their range of heavy duty quick-acting couplers Schraders have added one with an inlet thread of $\frac{3}{4}$ in, particularly suited to the pneumatic tools, drills and similar equipment which is power fed through wide bore hose.

The complete coupler consists of two parts—a check unit which is fitted to the air line and an adapter which is fitted to the hose attached to the tool or equipment.

When the adapter is pushed into the check unit it opens the line pressure to the tool, and at the same time snaps into a locked, airtight connection. The adapter will not disconnect accidentally, yet a twist on the sleeve of the check unit will release the adapter and immediately reseal the air line. When coupled the adapter swivels in the check unit. The rate of free air flow through the coupler is approximately 100 cu. ft per minute at 100 lb per sq. in inlet pressure. *A. Schrader's Son, 829 Tyburn Road, Erdington, Birmingham, 24.*

ANNEALING FURNACE
Continuous Radiant Flash Type



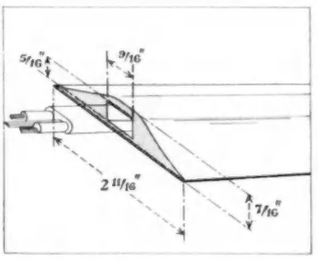
INSTALLED at the Dolgarrog works of the Aluminium Corporation is a continuous flash annealing furnace for the treatment of aluminium manganese alloy banks prior to deep drawing.

The furnace has a rating of 90 kW, it provides temperatures up to 900° C, and has a heating chamber 21 in wide by 15 ft long. Heating times for discs ranging from 6 in to 20 in in diameter and from 0·020 in to 0·080 in thick vary from 1½ to 4 minutes. The output of discs of 18 gauge material, 12 in in diameter is a little over 2 cwt per hour.

The radiation is obtained from heating panels which are fitted with heavy gauge nickel-chrome heating elements and positioned in the roof and the hearth of the furnace. Variations in heating rates are made by adjusting the spacing of the panels from the work, the roof and hearth being built as separate units suspended from the main framework of the furnace and contrabalanced. These units are moved by synchronously driven jacks operated by hand wheels which allow fine adjustments to be made to the heater spacing.

The charge is carried through the furnace on a horizontal conveyor which has two endless chains running along the sides of the chamber and carrying cross flights of heat resisting steel. The cross flights are covered with woven asbestos cloth to provide a non-abrasive support. The conveyor is driven by a squirrel cage motor through reduction gear; its speed can be varied between 4 and 30 ft a minute. *Royce Electric Furnaces Limited, Sir Richards Bridge, Walton-on-Thames, Surrey.*

RUBBER CONDUIT
Protection for Temporary Runs



FOR the many occasions when electric cables have to be layed temporarily across the floor, Vulcascot have introduced a protective rubber conduit strip.

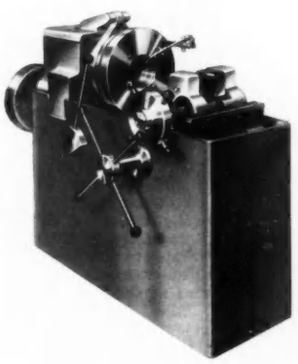
The strip is a rubber moulding, very roughly triangular in cross section, with a centre tunnel through which the cables can be run. This tunnel measures $\frac{9}{16}$ in by $\frac{5}{16}$ in and is therefore big enough to take the widest of the standard sizes of flat strand cables (three or four strands).

The edges of the strip that lie on the floor are tapered so that any vehicle will pass over them without difficulty, and also so that pedestrians will not tend to catch their toes on them. The bottom surface is serrated so that the whole strip will not easily shift on the floor when once it is layed in position. The maximum thickness of the strip is $\frac{7}{16}$ in so that even small wheels will not foul on it.

Made of a tough rubber, the makers say that the strip will not age in store, and can be taken up and reused. It is made in lengths up to 30 ft but part lengths are available from stock. The serviceability has been proved on floors where pedestrians, trolleys, fork trucks, and other light vehicles have been constantly passing over it. It is equally suitable for office use.

As an alternative for those rare occasions when it is not possible to thread the cable through the tunnel, the bottom of the strip can be slit and opened to receive the leads. Protection is still afforded both to the cable and to the passing traffic. *Vulcascot (Great Britain) Limited, 87-89 Abbey Road, London, NW8.*

SCREWING MACHINE
2 inch Capacity

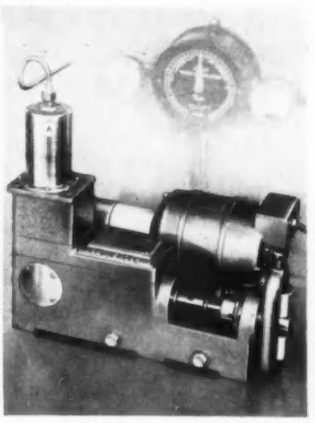


THE Maiden 2C/ST is a redesigned general purpose screwing and threading machine with a capacity from ¼ in to 2 in for pipes or bolts. A larger model will take up to 4 in.

The machine retains the taper mechanism of earlier models and also the lever release and close of the die head, which eliminates the need for stopping the machine after the completion of a thread. New features include the totally enclosed headstock with automatic lubrication and replaceable bearings; a forged steel replaceable head for increased strength and wear resistance; a narrow guided saddle with long bearing surfaces carried under the guide head; hammer action vice to reduce operator fatigue; and a large star traverse wheel for ease of thread start, with an inverted rack to prevent swarf damage. Also the whole machine occupies a smaller ground space.

The drive to the spindle is from an electric motor through V belts and reduction gears housed in the headstock. On the 2 in machine the speeds available are 19 and 54 r.p.m. and on the 4 in model 9, 14, 24 and 38 r.p.m. The speeds are obtained by pick-off gears that are easily changed. The maximum thread length that can be cut at one setting is 10 in on the 2 in machine and 12 in on the other. *Landis Machine-Maiden Limited, Hyde, Cheshire.*

METERING PUMPS
Automatic Control System Added

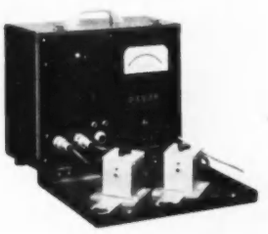


THE DCL "M" range of metering pumps used for small quantities of fluids, has now been adapted for automatic control in conjunction with pH, temperature, flow and other controllers.

The pumps are responsive to pneumatic signals of from 3 to 15 lb per sq. in, adjustment of the plunger stroke being carried out by a small, compact bellows motor operating through a mechanism designed to reduce hunting. Available with different plunger sizes giving a range of capacities from 0 to 750 cc per hour to 0 to 37·3 litres per hour, the pumps are suitable for working pressures up to a maximum of 2,400 lb per sq. in, the maximum pressure depending upon capacity. The output from each pump is proportional to the air pressure.

Pumps heads are interchangeable, the head in each case being easily removed and replaced by one of different capacity. Power is provided by a $\frac{1}{15}$ h.p. totally-enclosed induction motor. Valve bodies, seats and the valves themselves can be readily removed by merely slackenin one set screw to facilitate inspection and maintenance. Hydraulically operated diaphragm heads are available for applications where it is desirable to avoid having glands in contact with the liquid being pumped. *The Distillers Company Limited, Great Burgh, Epsom, Surrey.*

VIBRATION MONITOR
Frequency Range from 6 to 300 Cycles per sec.



THE Giesler vibration monitorin g equipment covers the frequency range from 6 to 300 c/s which is equivalent to from 360 to 18,000 r.p.m.

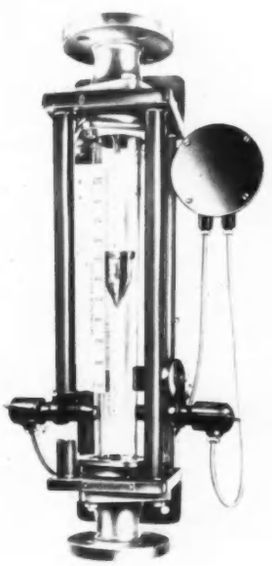
The equipment consists of a combined amplifier with amplitude meter, power supply unit and seismic transducer pick-up. There is provision for using a single or double pen recorder of the standard type, and two input sockets are fitted so that two transducers may be connected at the same time. A change-over switch allows the signal from either to be displayed at will. Standard power supply required is 200/250V 50 cycles single phase.

The equipment is contained in a portable light metal carrying case, fitted with a handle, hinged lid and clasps. The hinges are of the "lift off" pattern, so that the lid can be detached entirely, if required. When the lid is lifted, the control panel is exposed.

The range of amplitudes that can be read on the meter is from 0·0001 in to 0·1 in in four stages. There are two scales. The sensitivity is controllable and a readable pointer deflection can be obtained with any vibration ampiltude from 0·00025 in upwards.

Where required the equipment can be fitted with a relay, which permits of a machine being shut down when a pre-set level of vibration is exceeded. Thus, if it should be decided that a vibration amplitude of 0·007 in at the bearing position on a particular machine may cause damage, the monitor can be arranged accordingly to trigger a relay at this value, thereby operating a stop valve or switch. *C. F. R. Giesler Limited, Small Hall, River Place, Essex Road, Islington, London, N1.*

FLOW ALARM
For Standard Rotameters



FOR use with their industrial metric series meters types 907 and 914 (for service under rough mechanical conditions) Rotameter have developed a photoelectric alarm.

The alarm comprises a light source (6V 6W bulb run at 4V) and a photoconductive cell (Mullard ORP11 cadmium sulphide), housed in identical black plastics mouldings which clamp to diametrically opposite pillars of the chassis. Independent adjustments allow the alarm to be set at the required height and also to align the axes of the lamp and photocell centrally through the Rotameter tube. Thus, the alarm may be mounted on any size of frame in the types 907 and 914 series to give either maximum or minimum flow warning.

Leads from the lamp and photocell are fed to a separate junction box clamped to the chassis. Connection must then be made to the relay box which contains a mains transformer, an alarm relay, and a rectifier and measures approximately 7½ in by 4½ in by 5 in. *Rotameter Manufacturing Company Limited, Purley Way, Croydon, Surrey.*

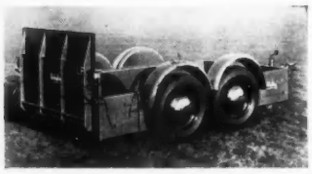
LOW LOAD TRAILER

Three Ton Capacity with Close Coupled Wheels

A THREE ton capacity low load trailer has been added to the Wrigley range.

It has an all steel chassis framework and a towbar of 5 in by 2½ in with a ¼ in steel plate platform measuring 10 ft by 5 ft 7 in. The sides are 12 in deep and are made of timber as is also the front board. The hinged tail board, which acts as a ramp, is 4 ft high and is made of ¼ in steel plate with reinforcing for heavy machine loading. The height of the hitch at the front of the towbar can be ordered to suit requirements. The whole is mounted on Flexitor rubber suspension units placed beneath to allow unrestricted floor space.

The steel disc wheels are detachable on 5 stud taper roller bearing hubs and are fitted with 650 by 16 8-ply tyres. On all four wheels are servo-assisted vacuum brakes having 11 in by 2½ in shoes; the bellows are mounted in the towbar. For connecting to the towing vehicle there is a flexible hose with a quick acting coupling. A hand lever



provides control when the trailer is being manhandled. There are also two independent hand levers for controlling the brakes on the rear wheels.

Attached to the tow bar is a combined lifting jack and jockey wheel which is screw operated. Over the wheels are domed steel mudguards with their inside faces in contact with the trailer sides steel panelled. At the rear are two stop/tail lights which incorporate reflectors and are connected to a plug and socket.

The trailer is finished in bright red or left in the primer as required. It has a platform loading height of between 12 and 13 in and an unladen weight of approximately 19 cwt. Extras include a one ton manually operated winch with a standard length of wire rope and a hook; a 12 ft long platform can be fitted as an alternative. *Wessex Industries Limited, West Street, Poole, Dorset.*

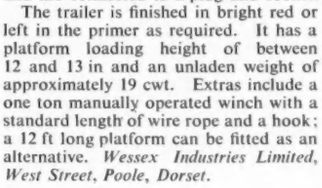
MINE PUMP

Solids up to 5/16 inch in Size

SPECIALLY developed for face drainage and general underground work, the Pegson Marlow 2 in type 2F1/1 self priming centrifugal pump will deliver up to 90 g.p.m. and will work against a static suction lift of 25 ft with a maximum head of 125 ft, passing solids of 5/16 in size.

Incorporating the Pegson Marlow patented diffuser feature, designed to give self-priming without liquid recirculation or auxiliary mechanisms, the pump has relatively large clearances to keep its priming efficiency even when excessive abrasion is encountered; the impeller and diffuser, which are cheap to replace after long hard use, are the only two parts subject to abrasive wear. There are no internal valves, no pressure relief valves and no foot valves required and it is claimed for the design that it eliminates clogging or jamming.

A soft-packed stuffing box, or alternatively a mechanical shaft seal, prevents air being drawn into the pump even on the highest suction lifts, and oil seals



safeguard the grease lubricated taper roller bearings against the entry of dust and grit.

The pump shaft, which is protected by a sleeve, is of ample proportions for horsepower and all duty conditions and is not subject to any hydraulic bending loads.

The pump can be supplied with or without power unit; in the former case a Buxton flameproof motor is fitted. It can be made of materials which are resistant to water containing corrosive acids. It is said that the pump will work satisfactorily even when standing at an angle. *Pegson Limited, Coalville, Leicestershire.*

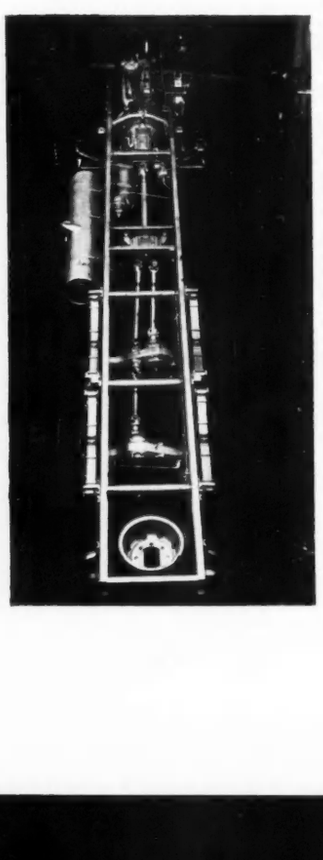
ALBION REIVERS

Range with Both Rear Axles Driven

AN additional range of six-wheel Albion Reiver haulage and tipper chassis has been introduced, the main difference being that both rear axles are driven.

The chassis have been developed for a gross laden weight of 15½ tons (the chassis and cab weigh 4½ tons) and there are two haulage and one tipper models.

The engine is the Leyland 0·375 diesel which develops 105 b.h.p. at 2,200 r.p.m. It drives through a single dry plate clutch and a five speed constant mesh gearbox, with an optional sixth speed overdrive, to the separately mounted relay gearbox (with third differential) and so to the differentials on the axles and the epicyclic reduction gears on the hubs. The drive to the leading axle, which has an offset differential, is coupled direct to the relay box while the other shaft passes through the leading axle body to the read differential which is offset on the opposite side. The third differential can be locked to give traction on soft ground. *Leyland Motors Limited, Leyland, Lancashire.*



WIDE BELT SANDERS

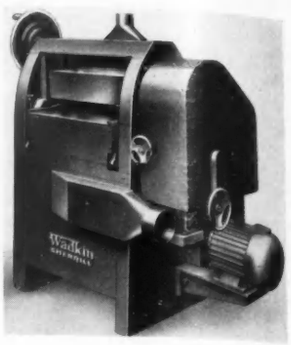
High Feed Rates Obtained

THE Wadkin range of wide belt sanders is based on the Sherrill Speed Feed design. It is claimed that stock can be fed at speeds up to 100 ft per min.

On certain classes of work a finish suitable for polishing can be obtained straight from the machine at feed speeds up to 50 ft a minute, and in all cases the volume of hand pad sanding can be drastically reduced.

The rate of speed is easily selected between 20 and 100 ft a minute. A spiral serrated rubber-covered roller is used for the feeding medium, which presses the stock firmly and evenly down to the sand belt and moves it forward at the selected speed. The serrated roller is automatically cleaned by a brushing action of a dust collector roller.

A feature of the design is the speed with which belts can be interchanged. One belt can be taken off and another substituted in less than 5 minutes. Long belt life is claimed due to the long length



of belt used, the oscillating movement incorporated in the machine, the deep serrations in the feed roller reducing belt loading and ensuring a cool belt, and also the efficient dust extraction. Belt oscillation can be provided if required and tracking is automatic.

There are three models with belts 24 in, 38 in and 52 in wide. The smallest weighs just over 1 ton, and the largest a little over 2 tons. *Wadkin Limited, Green Lane Works, Leicester.*

AIR COMPRESSORS

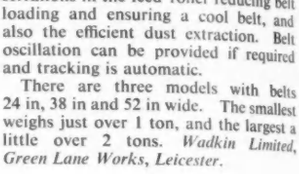
Electric Drive, Water Cooling

A DEVELOPMENT of the range of oil-cooled rotary "Power Vane" compressors is the introduction of the Class R range for stationary electric operation, together with optional water cooling of the oil as an alternative to air cooling when water supplies exist.

These compressors consist of a simple vane-type rotor positioned eccentrically in a sealed compression casing. The cooling oil is circulated by the pressure differential between the receiver and compressor and is metered by a gear-type pump.

Cooling of the oil is effected either in a fan-cooled radiator or, where it is necessary to avoid undue raising of the surrounding air temperature and adequate water supplies exist, by a water cooled unit. The new range consists of units with capacities of 100, 135, 160, 300 and 510 cu. ft per min at a pressure of 100 lb per sq. in.

Specific features include a gradual unloading control to regulate compressor output, Vokes Micro-Vee type



filters with cleaning device, and squirrel cage screen protected motors with star-delta starters for wall mounting. For mining service, plants are fitted with Teddington control panels and flameproof equipment is supplied where required in this respect. Some further additional features include the use of Norgren automatic drain valves and a hand-operated starting valve. To build up when starting and to bleed off this pressure when closing down, an automatic service discharge valve is installed on the discharge end of the oil separator. *Consolidated Pneumatic Tool Company Limited, 232 Dawes Road, London, SW6.*

INSULATION TESTERS

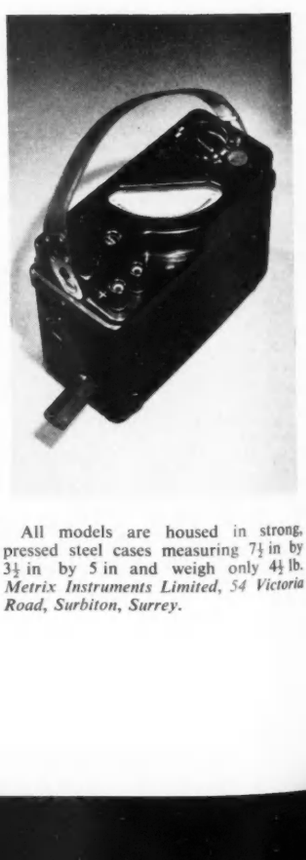
Portable and Accurate

THE Metrawatt range of insulation and earth continuity testers has been designed to meet the need for really portable, accurate, robust, yet inexpensive instruments.

The hand generator, which is very easy to turn, has fixed windings, the permanent magnet armature rotating in conjunction with a centrifugal governor. A contact rectifier is used and there are therefore no carbon brushes to replace. The design is aimed at producing negligible wear and extreme reliability. Accurate output voltages from 100 V to 5,000 V d.c. are available in conjunction with resistance ranges from 0·1 ohms to 4,000 megohms.

A completely sealed moving-coil meter is incorporated having an anti-parallax mirror and knife-edge pointer. The accuracy of the instrument is within 1 per cent.

A special three-terminal model for measuring earth resistance is also available. The instrument covers the ranges from 0 to 2 ohms to 0 to 10,000 ohms for full scale deflection.



All models are housed in strong, pressed steel cases measuring 7½ in by 3½ in by 5 in and weigh only 4½ lb. *Metrix Instruments Limited, 54 Victoria Road, Surbiton, Surrey.*

MORE SKILL FOR THE YOUNG

Speeches made by both sides of the House of Commons during the recent debate on youth employment problems were, in general, both forward looking and objective. A wide measure of praise was bestowed upon the work of the committee presided over by Mr. Robert Carr, when Parliamentary Secretary to the Ministry of Labour, and the committee's report *Training for Skill* (HMSO, 2*s* 6*d*) formed one of the main foundations for the whole discussion. Another document often mentioned with appreciation was Lady Gertrude Williams's *Recruitment to Skilled Trades*.

Mr. Alfred Robens, who opened the debate, was Minister of Labour in 1951, during the last Labour Government. He claimed that, although the problem of finding the right kinds of work for young people and of training enough skilled workers for the years ahead appeared at present as a cloud only the size of a man's hand, it could well become during the next few years, unless it were adequately dealt with, a storm that could overwhelm Britain's industrial abilities as a nation.

In his view, the future of this country was bound up not with the proper utilisation of her indigenous raw materials, of which there were few, coal being the largest, but with the proper development and use of the most important and most valuable material the nation possessed—her manpower.

TOO FEW APPRENTICESHIPS

It seemed, said Mr. Robens, from a recent report of the Ministry of Labour Advisory Council, that the number of people who would obtain professional qualifications as scientists and technologists must be doubled by 1970. Therefore, the country would then be producing about 20,000 qualified scientists and technologists a year. According to the programme for technical education, it was intended to produce what was at present estimated to be required, namely five or six technicians to every technologist.

But it was no use getting first-class technologists and an army of technicians to support them, unless there were to be, in the rear, the necessary number of skilled craftsmen who would have to work out on a machine what was put on the drawing paper. During the last few years, about 100,000 school leavers of 15 to 17 years of age had been apprenticed as skilled craftsmen. That was not sufficient; it had meant that a very large number of school leavers had not been given opportunities for skilled training.

As a result of the bulge in the numbers of school leavers it had been estimated that it would be necessary to increase the number of skilled apprenticeships to about 135,000 a year, merely in order to maintain the existing percentages of boys and girls receiving education as skilled craftsmen. And yet the last Ministry of Labour report had declared that in some industries, notably in the engineering group, apprenticeships were insufficient to absorb all the available candidates.

CAN INDUSTRY AFFORD IT?

Except by persuasion or legislation, industry could not be expected to provide the extra training places required, many of which would be surplus to present-day requirements. Industry was being asked to train about 22 per cent more apprentices than were needed. Could industry afford it?

Half of industry was conducted by firms with fewer than 500 workers and a very large proportion of firms had fewer than 100 employees. They could not afford the cost, because, from figures he had been given, the expense of training apprentices must represent between £15 and £20 million a year. The larger companies were not only prepared to undertake the training but he believed that they were ready to accept the increased burden, because they realised that, at some stage, they would need these extra workers. The larger firms, such as Metropolitan-Vickers, Imperial Chemical Industries, and some others, had their schools for apprentice training and those schools were the best to be seen anywhere. These firms would have to foot a bigger bill, because many other firms would not train apprentices, but there was a limit to what the larger firms could do.

IF INDUSTRY CANNOT DO IT—

Two other points mentioned by Mr. Robens were referred to also by Mr. Richard Wood, the present Parliamentary Secretary to the Ministry of Labour. Mr. Robens, he said, had questioned the five-year period for apprenticeships and the rigidity of the age at which apprenticeships started. Mr. Robens had felt that, in some instances, boys of 15, 16 or 17 should remain for a further period at secondary modern schools. This would spread the bulge and produce for industry boys of higher educational qualifications. Mr. Robens had also felt sure that three-year apprenticeships would be long enough in some cases, and that a committee should be set up to deal with all these matters.

Mr. Wood said that his own impression was that these problems were ones for industry to work out, and he thought that Mr. Robens shared that view. The Government had always felt that matters like these were essentially ones for consultation between the two sides of industry and it would give him (Mr. Wood) the greatest pleasure to see industry considering these questions. He emphasised that, although the report of the Carr committee was the basis for any advances that might be made at the present time, it was not to be considered as the last word on the subject.

It had been suggested by Mr. Robens that the Government should set up apprenticeship training centres at redundant factories throughout the country, such as those of the Royal Ordnance and Ministry of Supply, where there were qualified people and machinery in abundance, and where boys could be trained for the first one or two years of their apprenticeships. Instead of lads being apprenticed to particular firms, they would be apprenticed to the engineering industry as a whole. After their two years' special training, they would be able to be selected by firms to serve with them the final years of their apprenticeship courses.

—THE GOVERNMENT MUST

On this aspect, Mr. Wood said there were several reasons why the setting up of Government centres would be most unsuitable at present. Such centres would take a considerable time to establish, and, during that time, the Government's decision to take over industrial training would hardly encourage industry to provide extra places. Neither employers nor the Trades Union Congress could be expected to be favourable to such a scheme. Without the active enthusiasm of industry, there would be the danger of training young people who could not eventually be placed in suitable work and of giving the kind of training that industry did not particularly want.

As a result of the Carr committee's report, the Industrial Training Council had been set up to keep training and recruitment under review. With the approval of Parliament, said Mr. Wood, the Government proposed to make a grant-in-aid of £75,000 to the Council to further the appointment of training development officers, either by the Council, by employers' organisations or by joint industrial councils. The only condition for the grant was that £150,000 should be spent on this attempt.

Mr. Robert Carr (Conservative) referred to the surprise it had caused him, when he was at the Ministry of Labour, to find the extent to which there was an absolute shortage of skilled manpower, even in areas with employment difficulties. To those, particularly among trade unionists, who might feel that to attract more skilled trainees into industry might prejudice the future employment of their members, he would say that all experience during recent years had indicated that full employment would be easier to maintain if a larger proportion of the labour force of the future were skilled.

A number of interesting points were brought out by Mr. Austen Albu (Labour), who referred to estimates of the future needs for skilled workers given in Mr. T. A. Prichard's article "Boys and Girls Come Out to Work" (ENGNG, 28 Feb. '58, p. 278). He felt that small firms could not give the required training by themselves, and said it was a shame that group apprenticeship schemes, like those of the Engineering Industries Group Association and the Enfield Manufacturers' Association had not been more widely copied. He believed that there would have to be some method of tax relief for small employers joining in group schemes. A levy on industry might also be needed, based on the number of skilled workers employed, to establish training workshops in technical colleges. There would be relief for firms undertaking approved training. A scheme of this kind was in existence in France.

Exporting to Canada

Replying to Mr. Brian Harrison (Conservative), who wanted the President of the Board of Trade to supply information about United Kingdom exports to Canada, Sir David Eccles said that there had been an increase of 38 per cent between 1951 and 1958. Britain did a great deal to promote these exports. Lord Rootes, the chairman of the Dollar Export Council was visiting Canada in that connection. He agreed with Mr. Douglas Jay (Labour) that there was a large gap between what the United Kingdom sent to Canada and what Canada exported here. But, Sir David added, there always had been.

Supersonic Transport Aircraft

The attention of the Minister of Supply was drawn by Mr. John Eden (Conservative) to the decision of the United States to enter the field of supersonic flight for transport aircraft by the 1970's. He asked what conclusions had been reached from a study of the recommendations of the Supersonic Transport Aircraft Committee.

Mr. Aubrey Jones said that this very important matter was still under consideration. Clearly, any plans being made by the United States would be very relevant to any decision by the British Government. Replying to Mr. Frank Beswick (Labour/Cooperative), who said that surprise had been expressed by informed people at the modest character of the committee's recommendations in regard to Mach numbers, Mr. Jones said he hoped that, when it came to making a decision on the report, the reasons for the decision and, indeed, the reasons for the recommendations, would be made public.

Conditions in Non-Ferrous Foundries

Mr. Frank Allaun (Labour) referred to delays in implementing the report of the Joint Standing Committee on Conditions in Non-Ferrous Foundries and said that the delay was causing concern among employees in the industry. It was, he pointed out, no less than five and a half years since the joint committee had been set up and eighteen months since the Minister of Labour had been asked about delays. He considered that the Amalgamated Union of Foundry Workers and other interested persons had good cause for complaint, and suggested that the existing regulations for iron and steel foundries should provide a helpful basis for decisions.

Work was proceeding, replied Mr. Richard Wood, the Parliamentary Secretary to the Ministry of Labour, on a draft code of regulations. This draft would be published and interested parties asked for their comments. He agreed that things had taken a long time but said he did not regard the union as having cause for complaint. The joint committee's report was very long. It was bound to take time.

Queens in Succession

The replacement of the two "Queen" transatlantic liners cannot be deferred much longer. They were built in the early thirties, when the British tradition of luxury travel meant ample space, high ceilings (the public rooms are three decks high) and lordly comfort. Twenty years later the liner "United States" was built, more compact, faster and with equivalent carrying capacity. Since the war, competition has arisen in an acute form from luxury transatlantic air travel. The problems of the owners, the Cunard Steam-Ship Company, were outlined by their chairman, Colonel D. H. Bates, in his recent statement to shareholders.

Cunard see quite clearly the need to replace the two ships, and consider this likely to be worth while provided the company are helped financially from public funds. The American Government built the S.S. United States in 1952 at a cost of £27 million; they sold her to the United States Lines Company for £12 million. They now propose to build a sister ship at an estimated cost of approximately £40½ million and have undertaken to sell the vessel to the operators at a fixed price of £16½ million. Colonel Bates said that the French Government are also subsidising the construction of the S.S. France for their national prestige in the North Atlantic and that the Italian Government have taken similar action. Cunard could only contemplate replacing the "Queens" on such a basis.

The Government have already accepted in principle the need to extend some special assistance to Cunard in this matter. Whether or not this will in fact be to the full extent of closing the gap between historic and replacement cost remains to be seen.

The new ships will be considerably smaller in size, each about 50,000 to 55,000 tons gross compared with over 80,000 tons for the existing "Queens." The problem facing Cunard is to design such vessels carrying about 2,000 passengers at speeds of 28½ knots, which will allow them to carry on the same weekly service as at present.

A partial solution will be provided by the more efficient and less bulky steam turbine machinery now available and by the use of lighter construction materials. Reliability will be a major consideration, as will timing. It is unlikely that nuclear propulsion will be selected, for a delay of five to six years will probably elapse before a satisfactory unit has been developed.

What the Russians Want

The placing of a £15 million order with Prinex Limited, a subsidiary of Courtaulds, by the Soviet importing trade organisation Techmashimport, Moscow, gave sudden and startling confirmation to the statement of Mr. S. F. Anfimov, deputy trade representative of the USSR, at the recent meeting of the Russo-British Chamber of Commerce. Mr. Anfimov stated that negotiations were going on with British firms about the purchase of a second acetate rayon plant, a plant for the production of tyre cord, of polyacrilnitryl fibre and three sugar plants. He put the value of these orders at about £50 million.

Courtaulds have been most successful in their endeavours to sell machinery and technical know-how to Soviet Russia. Last July they obtained a contract worth several million pounds to supply machinery for a textile factory. The present contract covers the supply of complete plants and technical processes for the manufacture of viscose rayon tyre cord, acrylic staple fibre and cellulose acetate yarn. Courtaulds will be responsible for the erection of plants and for putting them on steam.

An interesting feature of Courtaulds' approach to the development of overseas trade in plant and machinery was the registration of Prinex earlier this year. The new company, headed by Mr. C. F. Kearton, was formed to negotiate overseas contracts. This is often a complex matter, with consideration of credit terms, currency availability, export restrictions and the like. The Russians will pay for the new machinery in sterling, partly in cash and partly on medium credit terms (five years). Deliveries will begin in May, 1960.

Glaceries Belges

Glass making is one of Belgium's oldest industries. It is also one which is likely to suffer most from the fiercer competitive conditions of the European Common Market. About 85 per cent of the output of flat glass is exported as against only 35 per cent exported in the hollow glass sector. The latter, which includes bottles and containers is up against stiffer competition in the home market. Both sectors of the industry have excess capacity.

The main firms in the sheet glass industry are the Union des Verreries Mechaniques Belges, which turns out about half the nation's output, Glaver, the biggest producer of plate glass, Glaceries Réunies and Glaceries de la Sambre. Bottle making is represented by three firms, Verreries Bennert-Bivort et Courcelles Réunies, Verreries des Hameendes, and Verreries du Pays de Liège et de la Campine. Several of these concerns, as the names indicate, are the result of mergers. These were carried out between the wars when the trend in the industry was increasingly towards mechanisation. As a result the industry has a complicated financial structure with two large holding companies at its summit. One of these belongs to the Société Générale, the other to the Brufina Group.

The position of Belgium as the world's principal sheet-glass exporter (40 per cent of world total) has been threatened since the war by the total banning of glassware imports into China, Latin America and Eastern Europe. Indeed the Iron Curtain countries are now serious export rivals, especially in African and Asiatic markets. Other countries which were formerly good customers for Belgian glass have expanded their own industries. One complication is that the biggest competitors among bottle makers are the Germans and Dutch, both of whom will have increasingly easy access to the Belgian market as tariffs are reduced. However the high level of building activity in Belgium, the increasing use of safety glass and the cost benefits of cheaper fuel oil are all factors favouring the industry. The big advantages that Belgian glass has are high quality and short delivery dates.

Strip Mill Under Control

Steel is an industry with a long tradition, which it is not afraid to leave behind. The older industries are notoriously conservative, but steel is an exception to the rule. Few firms, even in the vanguard industries, have, like the United Steel Companies, a department of operational research and cybernetics. Another example of the forward outlook is the development of automatic gauge control for strip mills by Davy and United. This system is employed in a new medium-width strip mill built by the company for Steel, Peech and Tozer.

As part of a planned extension of their resources for the production of medium width strip, for which a considerably expanded market is foreseen, Steel, Peech and Tozer, a branch of the United Steel Companies Limited, have placed an order with Davy and United Engineering Company Limited for a new cold strip mill for their Brinsworth plant. Fed by the Brinsworth hot strip mill, which Steel, Peech and Tozer brought into production some months ago, the new cold reduction mill, a 10½ in and 26 in by 22 in 4-stand tandem, will be capable of rolling mild steel and high carbon strip from 4 in to 18 in wide at speeds up to 2,100 f.p.m.

The mill will be equipped with electronic equipment capable of controlling the thickness of the rolled strip automatically. This system, produced originally under the patents of the British Iron and Steel Research Association, has been widely developed by Davy-United. It enables much more consistent accuracy in the rolled strip than is possible under manual control, with subsequent reduction of waste or off-gauge material. The value of Davy-United's order exceeds £300,000 and the whole plant is due to go into service in the summer of 1960.

High Pressure Connection

A new licence agreement was concluded recently between Ruston and Hornsby of Lincoln and the Gray Tool Company of Houston, Texas. This gives Ruston's the right to exploit a range of well-established patents, which cover high pressure and temperature connections utilising a unique sealing system for high speed connection of standard pipe sizes and many other adaptations. They will be sold as Ruston-Grayloc.

In their announcement, Ruston's say that these units will be the first of their type to be available outside the United States and that industries employing high pressures and temperatures will find that they yield important advantages, particularly in assembly and breakdown time, and that they offer a saving in weight and cost over conventional flanged assemblies.

Handley Page of History

The entire history of aviation, how it emerged early in the 20th century, from the speculative to the scientific, experimental and operational, is contained in the 50 years of Handley Page which have just been completed. Frederick Handley Page founded the company in 1908 after "much theoretical and practical aeronautical pioneering work," at Barking, near London. It was the first company to be constituted exclusively for the design and manufacture of aeroplanes.

The progress of Handley Page, from the first aircraft they produced, the Blue Bird in 1909, to their crescent-shaped Victor bomber, was rapid and exciting. Their first big success was a small 50 h.p. monoplane which flew in 1910. In 1912 they moved from Barking to Cricklewood with a factory area of 20,000 sq. ft, and constructed there the first aircraft built to a government contract. At the outbreak of the First World War, Handley Page produced the world's first "heavy bomber," the twin-engined 0/100 which first flew in 1915, and subsequently the 0/400 which became the backbone of Britain's aerial offensive force. When the war ended four-engined aircraft were ready to bomb Berlin from British bases. The 13½ ton V/1500 had a 126 ft span and carried a useful load of 6½ tons at 100 m.p.h. and fuel for 12 hours' flying. Heavy bombers were followed by heavy transport planes during the period between the wars.

The company's own 0/400's were operated by a subsidiary, Handley Page Transport, on a London-Paris service inaugurated in 1919. When that company merged with Imperial Airways in 1924 the nucleus had been formed for the development of international air transport: 14 aircraft, nine of which were Handley Page. The Hannibal-Heracles Handley Page 42 biplanes, which first flew in 1930, were the world's first four-engined air transports and set new standards of reliability, luxury and safety.

Recent history is better known. The Halifax—"the father of all modern heavy bombers"—was the company's contribution to the war effort. Over 6,000 were made, and during peak production some 41 factories, 600 subcontractors and 51,000 people were employed on its manufacture. The company, who invented the slotted wing in 1919, are now making a boundary-layer control, which may prove an even greater contribution to flight efficiency.

Creating Apprenticeship Capacity

It was announced in the House of Commons last week that the Government will grant £75,000 subject to Parliamentary approval to help establish apprenticeship schemes while the population bulge is passing through the adolescent age groups. The grant is a once for all gesture for this limited purpose. The debate had been initiated by the Opposition, which considered that the need for apprenticeship facilities was beyond the means of industry to provide. There were too many small and medium sized concerns which could not run apprenticeship schemes. The Government should therefore step in and use unused ordnance factories for apprenticeship schemes, the youngsters being apprenticed to the industry rather than to any particular firm.

The Government thought that this would take too long and would hardly meet with enthusiastic support either from employers or the unions. They preferred a grant to encourage setting up schemes for firms or groups of firms—or for expanding existing schemes. There was general agreement that something should be done. At a time when the demand for apprentices was rising the numbers were falling. In 1957 some 95,200 went into apprenticeships but the figure was down to 93,200 in 1958.

The failure is clearly in the small and medium sized concerns. The larger ones have by now increased their apprenticeship capacity to somewhere near requirements. Another need is to overhaul apprenticeship schemes to fit modern needs in an expanding economy.

With One Hand Tied

Mr. William Carron was reelected last week as president of the Amalgamated Engineering Union with about 62 per cent of a poll that amounted to less than 9½ per cent of the union's members. It was thus a considerable personal triumph. If he could have got the great majority of his members to vote he would probably have romped home with a huge majority. As it is, he has shown that he could win through quite comfortably with deplorable support from his members against extreme left-wing opposition led by Mr. Reg. Birch. He has shown that either owing to the trend of the times or his own popularity (probably a mixture of both) he can get by without any seriously organised anti-Communist support.

There have been signs of late of caution at the top of the AEU. The recent Dagenham strike was handled with great circumspection, some would have said indecision, in higher official circles of the union. In the most recent case where Mr. Carron has taken a strong policy line, on the 40 hour week, he has been defeated by his own executive. It may be that with the election safely behind for another five years, Mr. Carron may get tougher with his own members while maintaining a becomingly tough attitude to employers.

Holidays and Pay

Demands for more pay as well as shorter hours for members of the Amalgamated Engineering Union will be put forward by the union executive this summer. The annual meeting of the national committee of the union was the occasion for a clash between the president, Mr. William Carron, and Mr. Reg. Birch. Mr. Birch, whose defeat by Mr. Carron for the presidency is referred to in the previous note, carried the day and got a big majority backing for a resolution that the executive should "press vigorously" for the 40 hour week, and for "direct action to enforce it" if the employers turn it down. The following day the executive decided unanimously to seek a 15 per cent increase in basic rates of pay for 3 million engineering and shipbuilding workers. Mr. Carron's plea for moderation—in the opening presidential address—received the support of only 20 of the 52 members of the executive.

The reelection of Mr. Carron as president of the AEU showed that his thoughtful realism is not without supporters. His own union are probably more militant than most of the 40 unions affiliated to the Confederation of Shipbuilding and Engineering Unions. The claims to which the AEU executive are committed—they include higher wages for women and juveniles as well as for an immediate 15 per cent increase in pay and the 40 hour week—will be put to the meeting of the Confederation in June. Some watering down will almost inevitably take place.

An agreement, published last week, *Payment for Holidays—Manual Workers*, between the Confederation and the Engineering and Allied Employers' Federation establishes the principle of annual holidays proportional to the number of weeks worked during the year. Every manual worker—whether skilled, semi-skilled or unskilled—will be credited for each full week's work performed with "one twenty fifth of the sum of the appropriate consolidated time rate of his class plus one-sixth, or one twenty-fifth of the rate at present used for calculating his holiday credits, whichever is the greater." Examples show that a skilled setter-up's holiday pay can be 227*s* 1*d* a week, that of a fitter 217*s* 9*d* and that of a labourer 183*s* 7*d*. The document, which includes notes on method of application, is a tribute to the intelligence of both sides to seek a fair and practical solution to their differences.

Of Mars and Men

Scientists have begun to get really excited over the possibilities of space travel. Significantly, perhaps, the excitement is centred in Moscow and Washington. Two Russian professors, Kazantsev and Lapunov, interpret the great explosion which took place in a Siberian forest 51 years ago and devastated an area 70 miles in diameter as "a rocket or ship coming from Mars under atomic power." They challenge the theory of a meteorite, pointing out that in the centre of the explosion area only the tops of the trees had been snapped off, and that no traces of a meteorite and no crater were found. Kazantsev has been accumulating evidence for the spaceship theory for years and after the atomic explosion in Hiroshima became convinced that "an atomic explosion took place in Siberia at the height of one and a half miles." The shock waves were registered in England. Radiation measurements are now being taken.

At the Harvard Observatory, Dr. Gerard de Vaucouleurs advanced the theory that there was life on Mars, based on observations of the infra red spectrum of the dark areas on the planet. Dr. W. M. Sintom, of the Yerkes Observatory working at Mount Wilson, told a symposium of the National Academy of Sciences and the American Physical Society that "the particular spectral lines obtained are characteristic of chemicals in which hydrogen and carbon atoms are linked together in the neighbourhood of oxygen atoms." Another Soviet scientist, Dr. L. Shklovsky, published theories that the two moons of Mars, Phobos and Deimos, are "artificial satellites put into orbit by intelligent beings who might have inhabited Mars 2,000 million or 3,000 million years ago." No methods found in nature could explain either the origin of the two moons or the strange movement of Phobos. Although they might weigh 100 million tons or more, their construction would present no insoluble engineering problems.

Perhaps men will be able to take a clear look at Mars before the end of the century. At the Saunders-Roe factory in the Isle of Wight, Mr. C. S. Cockerell has built prototypes of hovercraft which he considers will be able to "wave hop" on a cushion of air across the channel carrying 1,000 people and 100 cars. Many believe that this type of craft is used to explore the earth by those mysterious beings we are trying so hard to identify.

Guilds Outside the City

The City and Guilds of London Institute has left the City of London where it was born and from which it derives its name to go to Portland Place. This has been a milestone in the history of this child of the City and the Livery Companies. It has moved into larger quarters and the report of the City and Guilds for 1957-58 duly marks the occasion when the foundation stone was laid last year.

In an age when technical education is being expanded at an unprecedented rate, the City and Guilds is moving with the times. In 1939 it had just over 40,000 examination candidates and in 1958, a decade later, just under 130,000. Expansion outside the City has also meant something else. Increasingly the City and Guilds is developing its overseas work. The committee on overseas work has continued its work on the new Ordinary Certificates in mechanical engineering, electrical engineering and building. Final drafts of syllabuses were about completed at the time the report was written.

Keeping Tabs on Unemployment

The monthly statistics published by the Ministry of Labour may shortly be altered to provide quicker information on unemployment. A message from the Minister to this effect prefaces the March-April figures. In view of the "exceptionally long gap" between the time when unemployment statistics and figures of employment are available for publication—the two sets of figures are published separately this month and may be the normal practice in future. A new table, giving regional totals of unemployment among young persons, will be included each month.

In April the increase in unemployment among boys and girls was 8,000 made up of a decrease of 5,000 from those registered on 9 March, together with an increase of 13,000 Easter school leavers registering for the first time. Overall unemployment continued to fall, by 20,000 between 9 March and 13 April. There were on that date 531,000 persons registered as unemployed, of whom 45,000 were temporarily stopped. The percentage unemployed in April was 2·4 per cent compared to 2·5 per cent in March and 2·0 per cent in April, 1958.

Panegyric to Youth

There are men who like being called Junior—and these men are an Institution; moreover they will like to be wished a happy anniversary, for their corporate body is now seventy-five years old. Rather this body should be called seventy-five years young, for not only do the members of the Junior Institution of Engineers retain the spirit of the younger engineer, but they look forward to many more years of "inspiration and integration." These last words are those of their president, Mr. W. M. Larke: he is part of a tradition—partly in the fact that the Institution has both a president and a chairman, but further in the proud fact that his father, the late Sir William, was president before him.

Call them Juniors—they thrive on it; but remember that these men, whose age limit is certainly not 26 years as it once was, derive their inspiration from the careful integration of past and present achievements; they have the wisdom to look back, but the inspiration to look forward—what better foundation could there be for building an Institution.

THE EIGHT CONTENDING NUCLEAR SHIPS

BRITAIN has taken to nuclear propulsion of merchant ships in diverse and dramatic fashion. Seven companies and groups of companies have presented proposals for ship reactor systems, and the United Kingdom Atomic Energy Authority have described an eighth as a yardstick for the others. The variety of these systems appears to be in conflict with earlier British policy; or it may be indicative of a new attitude towards reactor development, with private industry playing a greater part in feasibility and basic system studies. The diversity of the proposed reactors is both impressive and revealing, hinting at the existence of hitherto unexploited design resources in British nuclear industry. Although these companies have long been interested in nuclear propulsion, certain schemes described have been prepared during the last six months. It is likely that more than one system will mature: a tried conventional design at an early date; an advanced system late in the 1960's; and others at intermediate stages. The details of the seven company systems are summarised in the following notes together with data for the Advanced Gas Cooled Reactor, which forms the basis of the UKAEA design. The arrangement in a 65,000 ton tanker of an advanced form of gas-cooled reactor with 1·3 C_0 enrichment (an earlier design by Vickers Nuclear Engineering) is shown to indicate a possible layout of reactor and propulsion plant. The world situation in nuclear ship propulsion was reviewed in Atomic Review last 24 April.

Rival Systems for Surface Ships

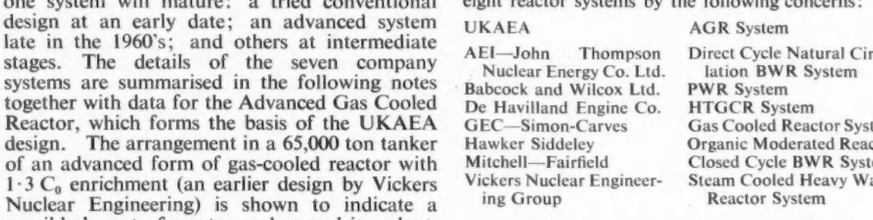
Under arrangements made by the Admiralty and with the agreement of the UKAEA a series of papers has been read and illustrated by the Atomic Energy Authority and several British nuclear engineering firms on a variety of reactor systems capable of use in surface ships. The demonstration was recently given in London to audiences consisting of the Board of Admiralty and Admiralty naval and civilian staff, the Ministry of Transport and Civil Aviation and other Government departments, and the Marine Nuclear Propulsion Committee, which sits under the chairmanship of the Civil Lord of the Admiralty and comprises representatives of the shipping, shipbuilding and marine engineering industries, Lloyd's Register of Shipping, the Atomic Energy Authority and several Government departments. The project was organised to inform the British shipping and shipbuilding industries the Admiralty, and other Government departments of the present state of the nuclear art in ship propulsion. Papers were read on eight reactor systems by the following concerns:

UKAEA	AGR System
AEI—John Thompson Nuclear Energy Co. Ltd.	Direct Cycle Natural Circulation BWR System
Babcock and Wilcox Ltd.	PWR System
De Havilland Engine Co.	HTGCR System
GEC—Simon-Carves	Gas Cooled Reactor System
Hawker Siddeley	Organic Moderated Reactor
Mitchell—Fairfield	Closed Cycle BWR System
Vickers Nuclear Engineering Group	Steam Cooled Heavy Water Reactor System

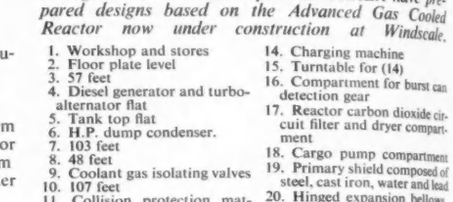
The systems possess different characteristics in terms such as weight, size, capital and operating costs and other technical factors. Not all of them are equally advanced for early use. All designs would have to be examined for safety by the UKAEA and the Ministry of Transport and Civil Aviation. The claims made for each have now to be assessed by a technical subcommittee which the Civil Lord's committee is setting up to report as early as practicable. The report will help to determine which system offers the best advantages, balanced against the time it would take to begin operation. Simultaneously, the main committee will be examining ways of financing the first ship. The Ministry of Transport Committee on Marine Nuclear Safety will continue its work already begun, on the problems of safety in nuclear ships, and in the harbours where they will follow their trade. The goal of the Admiralty Committee is the economic nuclear merchant ship.

Though not one of the eight systems proposed, this earlier arrangement of an advanced gas-cooled reactor in a 65,000 ton tanker by Vickers Nuclear Engineering shows how nuclear propulsion machinery might be arranged in a merchant ship. The UKAEA have prepared designs based on the Advanced Gas Cooled Reactor now under construction at Windscale.

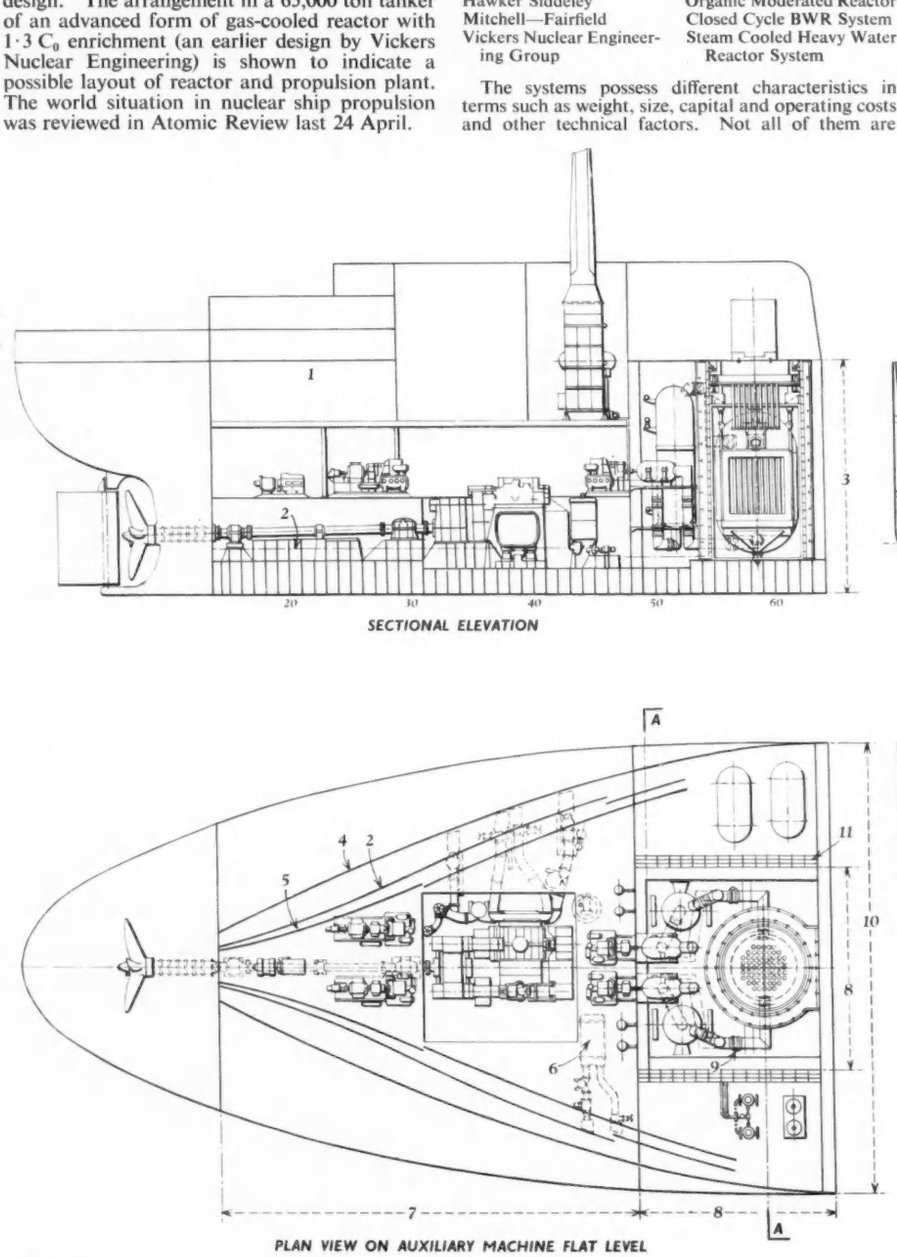
1. Workshop and stores
2. Floor plate level
3. 57 feet
4. Diesel generator and turbo-alternator flat
5. Tank top flat
6. H.P. dump condenser.
7. 103 feet
8. 48 feet
9. Coolant gas isolating valves
10. 107 feet
11. Collision protection mattress
12. Forced circulation pumps for steam drums
13. Discharging and refuelling compartment
14. Charging machine
15. Turntable for (14)
16. Compartment for burst can detection gear
17. Reactor carbon dioxide circuit filter and dryer compartment
18. Cargo pump compartment
19. Primary shield composed of steel, cast iron, water and lead
20. Hinged expansion bellows
21. Carbon dioxide evaporator and storage compartment
22. Biological shield and reactor compartment ventilation fan (induction fan)



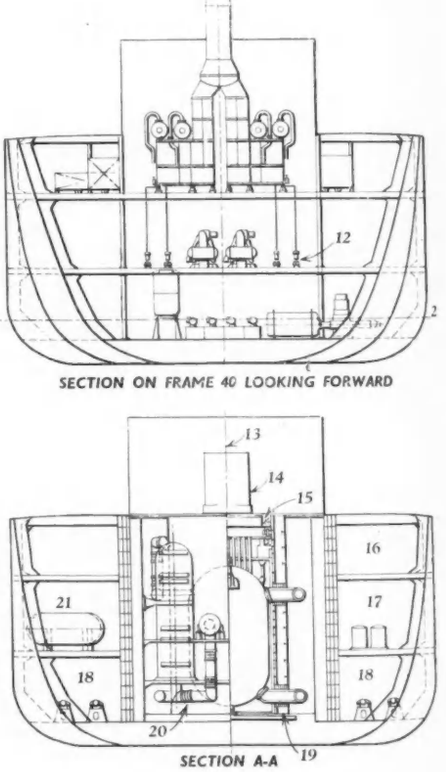
SECTIONAL ELEVATION



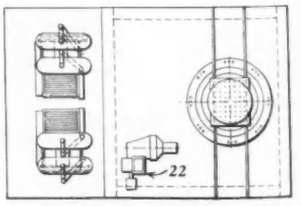
SECTION ON FRAME 40 LOOKING FORWARD



PLAN VIEW ON AUXILIARY MACHINE FLAT LEVEL



SECTION A-A



PLAN VIEW OF EMERGENCY BOILER AND REACTOR FLATS

UKAEA: Advanced Gas Cooled Reactor

Although designs have not been published, the system proposed by the UKAEA in conjunction with the Admiralty is based on the Advanced Gas Cooled Reactor (AGR) now building at Windscale. The heat rate of this reactor (100 MW) corresponds to a shaft horsepower of about 35,000. Other parameters of the AGR, which employs uranium oxide fuel and beryllium canning, permitting high gas temperatures, are given in the table.

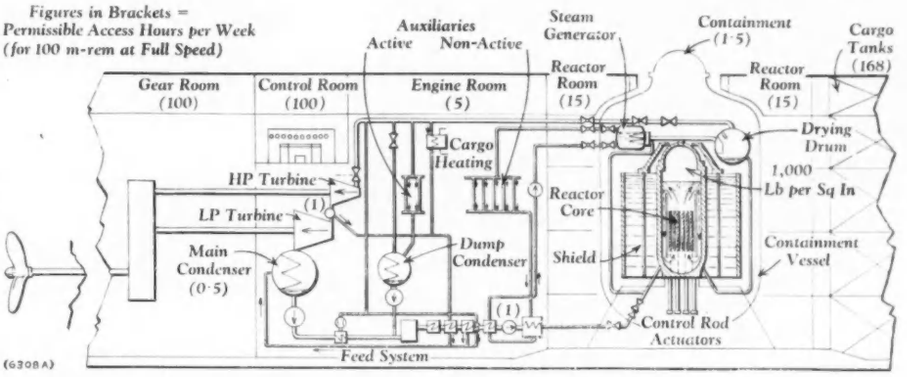
To adapt the AGR for marine propulsion, certain modifications may be conjectured. To reduce core size and hence shielding weight, the marine reactor is likely to have a higher heat rating. With this object there will be greater subdivision of the fuel and thinner fuel sections (high surface to volume ratio) in order (*a*) to facilitate heat removal and (*b*) minimise internal fuel temperature. Another means of reducing reactor size is to employ a spherical core, since optimum neutron efficiency is achieved with this geometry. At the same time a sphere is the ideal shape for a pressure vessel, permitting a higher coolant pressure and contributing to the increased heat-removal requirement. Core size may also be reduced by raising the fuel to moderator ratio: firstly by simply cutting the quantity of moderator and increasing enrichment to compensate for loss of moderating effect; and secondly by increased dilution of fuel in moderator also calling for added enrichment. Excess reactivity will be incorporated to provide xenon overide.

A dump steam condenser may also be included to permit short-term variations in power requirements and an auxiliary diesel plant. To reduce burnup differential and simplify batch refuelling, the neutron flux is likely to be flattened, at the same time increasing core efficiency. Burnups above 6,000 MWD per tonne may be specified. Shielding material of higher density (and greater thickness to allow for increased neutron leakage with the smaller core) will be used and a supporting structure capable of withstanding high dynamic forces. Minimum s.h.p. for economic operation is about 25,000.

Sir John Cockcroft has given 0·2*d* per s.h.p. now as the fuel cost for one UKAEA study: from published graphs (Geneva Conference P266, Moore and Iliffe) it may be shown that this figure applies to a 40,000 s.h.p. tanker operating with a burnup of 6,000 MWD per tonne—figures that accord with a study based on the Windscale AGR. The break-even points for operational cost (including capital repayment) with respect to oil-fired vessels for a 6,000 MWD per tonne burnup are at displacements of 44,000 tons (oil at 170*s* per ton) and 87,500 tons (135*s* per ton).

Conjectured Marine Modifications for AGR (in Brackets)

Reactor heat rate	100 MW
(Net output	35,000 s.h.p.)
Core length excluding reflector (spherical,	14 ft
Core diameter excluding reflector reduced)	15 ft
Total number of channels (more)	250
Gas pressure at inlet to reactor (increased)	270 lb per sq. in g.
Gas temperature at inlet to reactor	250° C to 325° C
Bulk gas outlet temperature	500° C to 575° C
Normal maximum fuel can surface temp.	600° C
Total weight of UO_2 in core (further diluted)	14·6 tonnes
Mean reactor rating (increased)	7·75 MW/tonne U
Peak reactor rating (reduced)	18 MW/tonne U
Initial enrichment (increased)	1·65 C_0 approx.
Average thermal flux (increased)	$1·49 \times 10^{13}$ n per sq. cm sec
Peak thermal flux (reduced)	$3·45 \times 10^{13}$ n per sq. cm sec
Number of control rods (more)	25
Total reactivity absorbed (more)	14 per cent approx.
Internal diameter of cylindrical pressure vessel (spherical, reduced)	21 ft
Weight of moderator and reflec. (less)	200 tons approx.
(Shield thickness	9½ ft)
(Reflector to shield clearance	5 ft)
Superheater: Outlet pressure	620-670 lb per sq. in g.
Outlet temperature	860° F, 460° C
Dump condenser rating (same)	100 MW
(Specific plant weight	400 lb per s.h.p.)
(Thermal efficiency	32 per cent)
(Fuel costs at 6,000 MWD per tonne burnup	0·2*d* per s.h.p. hr)
(Capital costs: 50-100 per cent higher than for conventional plant)	
(Operating costs: 10-15 per cent higher than conventional plant)	



AEI-JT: Direct Cycle Boiling Water Reactor

The AEI—John Thompson Nuclear Energy Company offer a complete nuclear propulsion unit with guaranteed performance for large surface vessels. It comprises a direct-cycle boiling-water reactor and geared turbines and the delivery time quoted is 30 months. The General Electric Company of America, with which AEI has a technical association, have long experience of this system, and certain components for a first reactor would be purchased from them. Subsequently the entire unit would be made by the British group. Comparative fuel costs in pence per s.h.p. are given as 0·290 for a nuclear ship employing this system and 0·384 for a conventional vessel burning oil at 132*s* 6*d* per ton. The advantages of the boiling water reactor are said to be that it is: (1) simple, (2) light, (3) smaller than other reactors, and (4) capable of burning plutonium.

Data for AEI-JT Direct Cycle BWR Marine Propulsion Unit

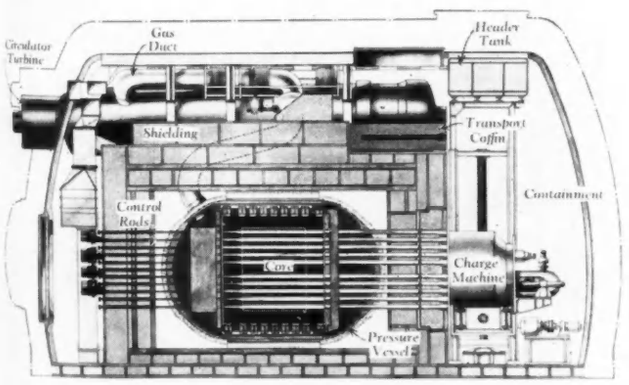
Guaranteed net output	25,000 s.h.p.
Efficiency	27 per cent
Reactor output at 50 per cent full load	82 MW (heat)
Primary circuit max.: Press. (lb per sq. in g.)	1,000 nom.
Temp.	286° C
Pressure vessel inside diameter	8 ft
Engine steam at full power	1,000 lb per sq. in g. dry sat.
Total estimated weight:	
Steam raising unit and shielding	1,600 tons
Turbines, gears and auxiliaries	250 tons
Specific plant weight	166 lb per s.h.p.
Endurance at full power without refuelling	380 days
Duration of refuelling procedure (overall)	100 hours approx.
Maximum lift during refuelling	35 tons
Decay heat removal: (1) Up to 45° list and for 30 min without power: By auxiliary steam/steam generators or passing primary steam to dump condenser. (2) Above 45° list and when reactor water lost: Core and containment sprays and sea water coolers. (3) Refuelling: Heat exchanger to cool reactor after 7 hours	
Core: Length (active length including spacers)	72·5 in
Diameter (circumscribed approx.)	62 in
Reflector material	H_2O
Number of fuel channels	104
Number of fuel elements per channel	36
Fuel: Type: sintered UO_2 pellets of 95 per cent theoretical density	
Initial enrichment	2·1 per cent U_{235}
Reject enrichment	1·0 per cent
Total weight in core	8·7 tonnes
Conversion factor	0·5 (approx.)
Average thermal flux	$1·4 \times 10^{13}$ n per sq. cm. per sec
Centre channel mean rating	17·2 MW per tonne
Average fuel burnup	10,000 MWD/tonne
Fuel element construction: pellets enclosed in can. Three cans coupled end to end to make one fuel element. 36 elements fitted inside square zircaloy box	
Fuel Can:	Zircaloy 0·033 in thick
Primary control means: hydraulic actuators driving cruciform stainless steel calcined boron steel; secondary control means: injection of boron solution using high-pressure stored gas	
Max. temp.: Fuel element centre at full power	2,000° C
Can material at full power	300° C
Number of steam drums	2
Coolant press. full output at inlet to 1,000 lb per sq. in g. norm.	
Reactor pressure vessel (banded):	
Internal diameter	8 ft
Overall height	30 ft
Design pressure	1,250 lb per sq. in g
Design temperature	300° C
Biological shielding, type	Steel and water
Secondary shielding: (*a*) engine room, gear room bulkhead: 6 in steel; (*b*) at end of steam drums: 2 in steel	
Containment vessel: Type, vertical cylinder; thickness, 2¼ in; dimensions, 38 ft diameter by 55 ft overall, including dome	

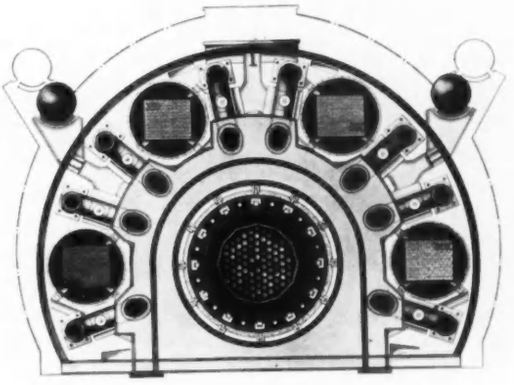
GEC—Simon-Carves: Gas Cooled Reactor

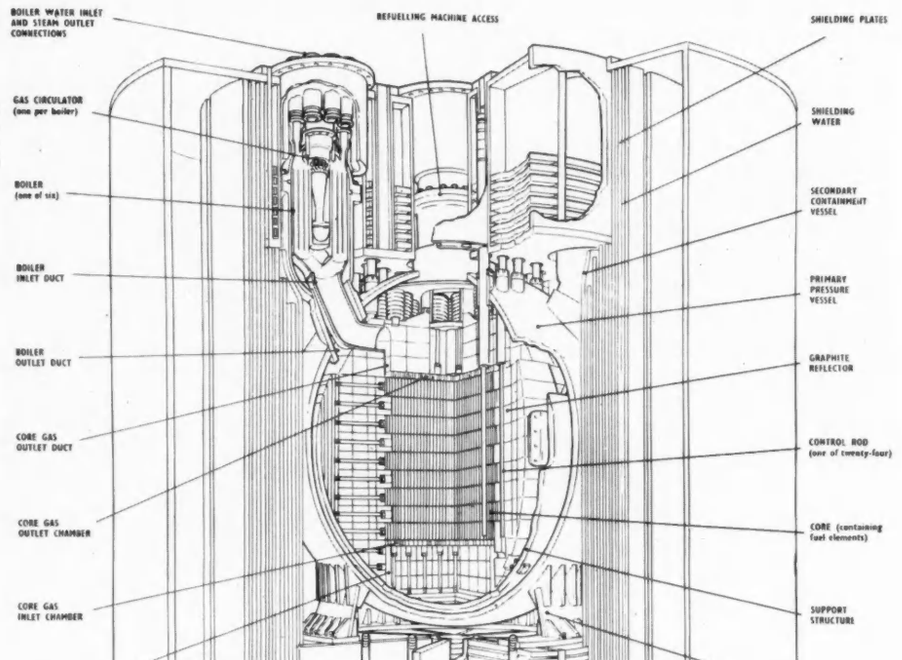
The G.E.C.—Simon-Carves Atomic Energy Group have condensed a conventional gas-cooled graphite-moderated reactor into a plant weighing 2,400 tons. The reactor (150 MW heat) with shielding, occupies roughly the same space as one Hunterston charge-discharge machine. The novel design of the reactors fuel elements allows heat to be extracted at a far greater rate than achieved so far with gas-cooled reactors. It is estimated that the first reactor of this type built for ship propulsion would cost £3 million. The advantages claimed include: (1) all technology currently available; (2) room for further development; (3) compactness (the illustration shows successive size reductions by outline of original design); (4) safety; (5) charging and discharging on load; (6) make-up carbon dioxide coolant could be made from bunker oil at sea; (7) low centre of mass; and (8) shock resistance.

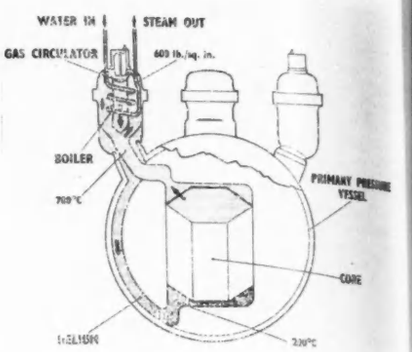
Data for GEC—Simon-Carves Gas Cooled Graphite Reactor

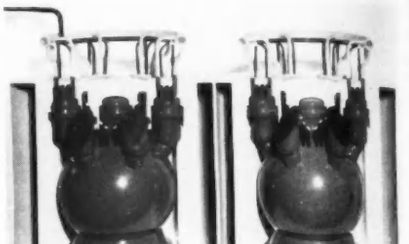
Reactor output	150 MW (heat)
Total containment volume	68,000 cu. ft
Total weight of installation	2,400 tons
Specific plant weight	200 lb per s.h.p.
Reactor pressure vessel: horizontal cylinder with domed ends; charge-discharge standpipes at one end; control rod and emergency access pipes at the other; nozzle forgings for gas ducts; ducts curve inside shield to minimise radiation leakage.	
Pressure vessel: Inside diameter	14 ft
Weight	125 tons
Bottom support grid: Length	56·5 ft
Weight	200 tons
Steam raising units: Number	4
Diameter	7·5 ft
Charge-discharge machine (pressurised):	
Length	12·5 ft
Containment vessel: truncated cylinder resting on a flat grillage; houses all nuclear and steam raising plant with the exception of the steam drums; minimum number of penetrations; filtration and cooling plant for shield water integrated into the system; although personnel would not normally enter the containment vessel during operation, it is safe for them to do so.	
Containment vessel: Weight	243 tons
Reactor core: graphite blocks held together and supported by a surrounding steel structure; fuel element channels extend horizontally through the core and are interspersed with control rod channels, also horizontal.	
Core diameter, 7·5 ft; length 6·75 ft	
Fuel: slightly enriched uranium dioxide	
Canning (to permit higher operating temperatures): stainless steel with impermeable graphite sleeves	
Shielding: surrounds and supports the pressure vessel and is made from steel plate; cellular structure, the voids being filled with purified water to act as a neutron shield.	
Control: neutron absorbing tubes; with shut-down rods inside.	











De Havilland HTGC Reactor

The de Havilland Engine Company Limited have proposed a propulsion plant based on a high-temperature gas-cooled reactor, similar to that being constructed at Winfrith Heath under the OEEC-UKAEA project, Dragon, which is due for completion at the end of 1962. The plant envisaged will employ two reactors installed in tandem, and though primarily intended for naval use, its development for naval purposes will cheapen its application to merchant shipping. Given a full-scale development effort costing about £13 million and commencing early 1960, it should be possible to launch a prototype ship late 1964.

The advantages claimed include: (1) high core heat rating and hence compact layout, small boiler size and low pumping power loss, with steam conditions corresponding to those currently used in naval machinery; (2) integration of the boiler-circulator units with the pressure vessel also leads to compactness and enables a secondary containment vessel to be fitted inside the main biological shield; (3) the twin reactors can operate independently in the event of failure or for facilitating manoeuvring; (4) in the event of complete failure of the coolant system, the decay heat produced after shutdown should be completely transferred to the surrounding graphite reflector structure by conduction and radiation without an excessive rise in core temperature; (5) large negative temperature coefficient; (6) long operating periods without refuelling—eventually 20 years; (7) good conversion ratio; (8) the dilute fuel suffers little radiation damage; (9) low capital cost; (10) low running costs due to low initial fuel investment and long core life; (11) no hazard even in collision; (12) since reactors do not project above deck, ship structure can be continuous; and (13) considerable development potential—greater output by increasing pumping power, circuit pressure and fuel element temperatures, longer core life (20 years with beryllia moderator), reduced capital cost by using closed-cycle gas turbine.

Data for DH Twin HTGCR Marine Plant

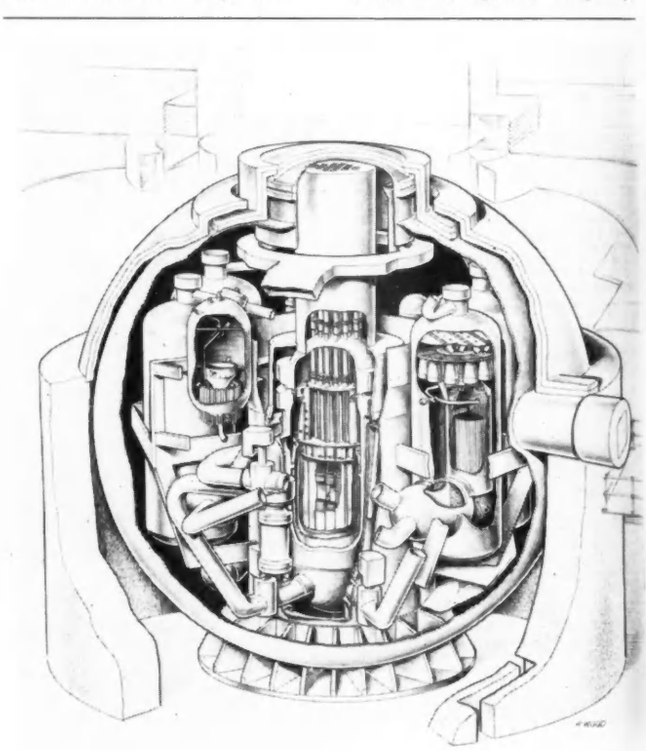
Net output (2 reactors): 50,000 s.h.p.
(1 reactor could power ship up to 65,000 tons)
Total reactor output (75 MW per reactor): 150 MW (heat)
Moderator: graphite (later beryllium)
Coolant: helium
Coolant press.: 735 lb per sq. in (1,000 later)
temp. reactor inlet: 200° C; outlet: 700° C
Maximum temp. at fuel pellet centre: 1,500° C
Mean operating temperature: 1,000° C
Maximum temp. of graphite: 990° C approx.
Number of boilers per reactor: 6
Pumping power per reactor: 530 kW
Steam temp: 850° F; pressure: 600 lb per sq. in
Overall height of reactors with plinth: 25 ft
Across outer containment: 25 ft 4 in
Length of twin installation: 49 ft
Core height: 6 ft equivalent diameter: 6 ft
Graphite reflector: 2 to 2½ ft
Number of fuel columns: 1,729
Number of fuel blocks per column: 9
Fuel: uranium carbide and thorium carbide bonded into graphite pellets sealed in impermeable graphite blocks
Initial uranium enrichment: 90 per cent
Total weight of U235 in core: 67 kg
Weight of thorium 232 in core: 674 kg
Average thermal flux: $4{\cdot}55 \times 10^{13}$ *n* per sq. cm. per sec.
Reactor mean fuel rating: 101 MW per tonne
Centre channel mean fuel rating: 101 MW per tonne approx.
Average fuel burnup: 65,600 MWD per tonne
Shielding: laminated, iron and water, serving as tertiary containment vessel
Total estimated weight of installation (2 reactors and 12 boilers): 2,400 tons
Shock resistance: 13g. vertical and 6g. lateral
Endurance at full power without refuelling: 400 to 650 days (4 years plus)
(With active circuit and beryllia moderator refuelling period: 20 years)
Cost of first production (twin-reactor) unit (less core fuel blocks): £1·4 million
Specific cost: £28 per s.h.p.
(With closed-cycle gas turbine £20 per s.h.p.)

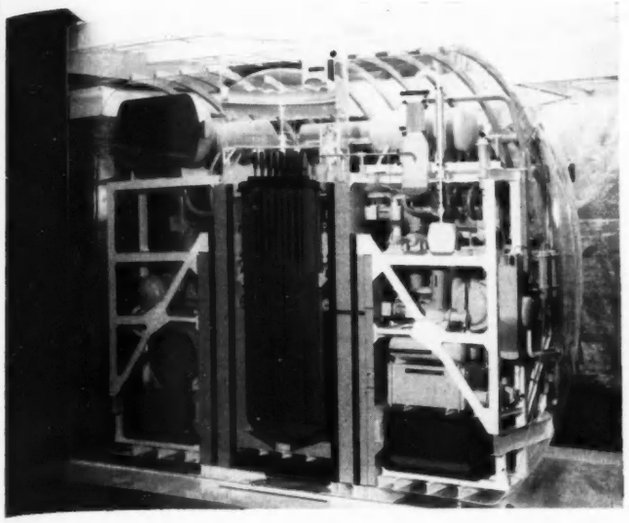
Babcock and Wilcox: PWR

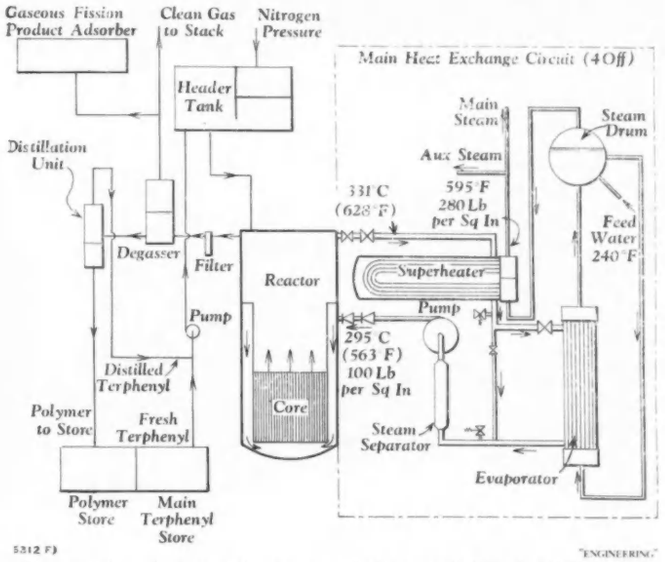
Babcock and Wilcox Limited have presented a project based on the pressurised-water reactor, a system adopted for all nuclear vessels so far building or in service. The plant will be similar to that being built by the Babcock and Wilcox Company of America for the Savannah, but, though occupying only 20 per cent more space, will have 2½ times the output. Construction can be undertaken now at a firm price for operation at a guaranteed output by the end of 1962, with manufacture wholly in this country. The advantages claimed are (1) well tried, (2) simple, (3) robust, (4) safe, and (5) inherently stable. Safety features include (*a*) natural circulation in the event of pump failure; (*b*) large-capacity boilers providing a buffer between reactor and turbine so allowing adequate time for emergency action; (*c*) provision against boiling which might lead to instability and deposits in the reactor circuit; (*d*) continuous operation at full power in the unlikely event of 5 per cent failure of fuel elements; (*e*) isolation of turbines and condensers from reactor coolant circuit so preventing mutual contamination and permitting independent water treatment in each circuit—maintenance within the containment vessel can thus be carried out minutes after shutdown; (*f*) strength of containment vessel sufficient to prevent any escape of radioactive material; (*g*) no special fluids, hence several alternative methods for replenishing coolant and moderator.

Data for Babcock and Wilcox PWR Plant

Guaranteed net output: 65,000 s.h.p.
Reactor output: 180 MW (heat)
Average coolant operating temp: 260° C
Average coolant pressure: 1,750 lb per sq. in
Containment vessel diameter: 42 ft 6 in
Evaporation: 616,000 lb per hour
Steam conditions (sat.): 410 lb per sq. in 447° F
Weight (reactor, boilers, ancillary equipment, overall containment, shielding): 3,000 tons
Fuel charge (enriched UO_2): 9 tons approx.
Enrichment: 2 to 4 per cent
Cladding: stainless steel or zirconium
Endurance at full power before refuelling: 500 days (2 to 5 years service)
Eventual cost of fuel: 0·3 to 0·6*d* per s.h.p.







5312 F) "ENGINEERING"

Hawker Siddeley: OMR

The Hawker Siddeley Nuclear Power Company have prepared a detailed design study of an organic moderated reactor plant. The system is said to be suitable for use in conventional merchant ships requiring high power. With modifications in output and the introduction of known design developments, it is expected to achieve lower than conventional operating costs in medium size commercial ships, say tankers of 40,000 tons. A plant of 17,000 s.h.p. would cost £890,000.

The advantages claimed are: (1) simplicity; (2) small size; (3) non-corrosive coolant (terphenyl); (4) the low vapour pressure of the coolant permits system pressures of less than 100 lb per sq. in, so that conventional equipment may be used in the primary circuit and mild steel in reactor-vessel and primary-circuit construction; (5) lack of induced activity in the coolant permits access to the primary circuit during operation; (6) the use of uranium oxide fuel and stainless steel canning provides corrosion resistance in the event of catastrophic entry of seawater; (7) fuel elements are in two sections to permit end to end fuel cycling; (8) negative temperature coefficient under all burnup conditions—this self-stabilising characteristic is expected to permit the vessel to manoeuvre as easily as a conventional ship; (9) plutonium enrichment may be used; (10) comparatively low cost of coolant replenishment; (11) considerable development potential—beryllium canning would reduce the fuel enrichment required, a graphite reflector would reduce operating costs by 2 to 3 per cent, cycle efficiency could be improved by use of a two-zone core (some coolant flowing into a hotter outer core region and thence to a superheater); and (12) higher heat transfer rates up to nucleate boiling would permit increases in output up to 60 per cent.

Data for Hawker Siddeley OMR Plant

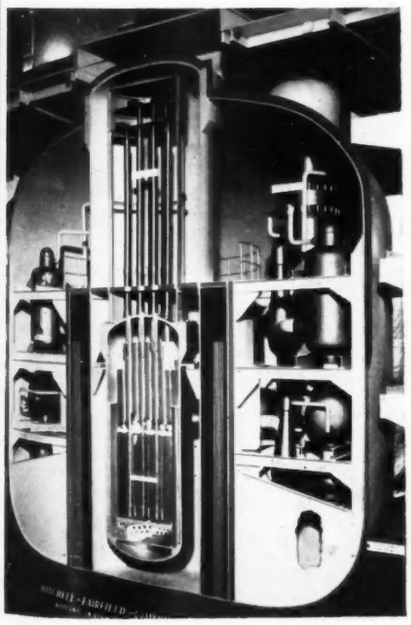
Net output: 17,000 s.h.p.
Reactor output: 56 MW (heat)
Overall cycle efficiency (with 2 zone reactor): 24·8 per cent
Weight of containment and contained equipment: 1,300 tons
(Boilers and oil bunkerage in corresponding conventional tanker weigh 4,000 tons)
Moderator and coolant: terphenyl
Number of primary loops: 2
Coolant pressure: 100 lb per sq. in
Coolant temp. (bulk)—inlet: 295° C, 563° F
Coolant temp. (bulk)—outlet: 331° C, 628° F
Coolant (outer zone)—inlet: 295° C, 563° F
Coolant (outer zone)—outlet: 405° C, 761° F
Cost of coolant make-up: 0·07*d* per s.h.p. hour
Fire safety measure: nitrogen rich air in reactor compartment to prevent ignition of terphenyl oxygen content of 15 per cent is breathable without use of special apparatus
Steam conditions at t.s.v. (2 zone reactor): 480 lb per sq. in at 710° F
Core diameter: 5·2 ft
Fuel: uranium dioxide
Fuel canning: stainless steel (later beryllium)
Fuel enrichment: 1·4 per cent ($2C_8$)
Fuel height: 5 ft
No. of fuel elements: 264, each of 19 rods
Xenon override: Yes
Fuel cycling: one or two years to suit operator
Two zone reactor permits 9 per cent reduction in fuel costs with only 2 per cent increase in terphenyl replacement costs
Operating costs for 40,000 organic reactor powered tanker would be about 5 per cent higher than for conventional vessel

Mitchell—Fairfield BWR

A consortium of three companies, Mitchell Engineering Limited of London, the Fairfield Shipbuilding and Engineering Company Limited of Glasgow and Combustion Engineering Incorporated of New York, have proposed a surface-vessel propulsion plant based on a closed-cycle boiling water reactor. Two versions are offered with outputs of 25,000 and 50,000 s.h.p.; the smaller is understood to be capable of propelling a merchant vessel up to 100,000 tons displacement, and two of the larger units would propel a large liner. The consortium say that their propulsion system would be ready for seagoing trials in 36 months. The turbines will incorporate reheat by nuclear means. Advantages of BWR are (1) simplicity, (2) lightness, (3) compactness, (4) self-stabilising and (5) ability to burn plutonium.

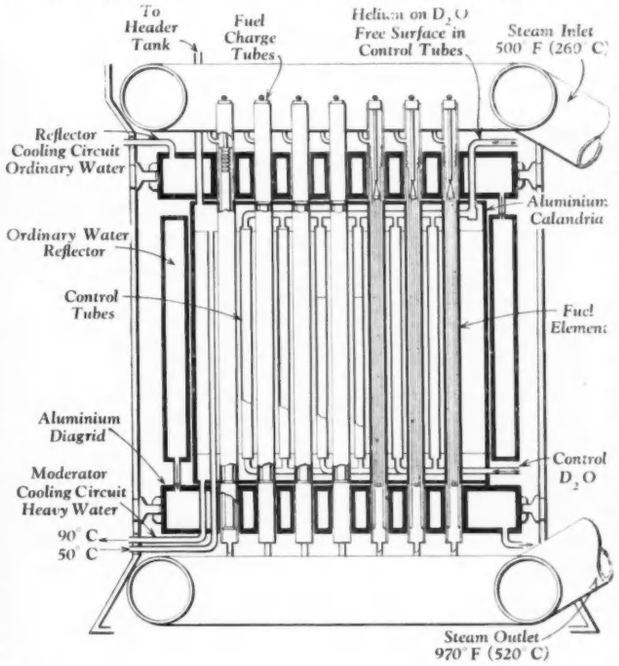
Data for Mitchell-Fairfield BWR Plant

Net output: (*a*) 25,000 s.h.p. (vessel up to 100,000 tons); (*b*) two reactors each 50,000 s.h.p. (large liner)
Coolant and moderator: light water



Vickers: Steam Cooled HWR

Vickers Nuclear Engineering Limited, comprising Rolls-Royce Limited, Foster Wheeler Limited and Vickers-Armstrongs Limited, have completed a feasibility study of an advanced and novel reactor system in which heavy water is the moderator and steam the coolant. This reactor system has been designed right from the start for ship propulsion. The steam coolant flows in a closed primary circuit (with thermocompressor self-circulation) and separate steam is generated in a second circuit to drive the turbines. The advantages claimed are: (1) safety from radiation hazards, since only primary circuit contaminated, stability, and reliability; (2) elimination of many shielding problems; (3) the use of heavy-water moderator makes possible a small light reactor because of its high neutron economy; (4) a liquid moderator offers versatility and presents fewer problems in marine applications; (5) proven technology—the art of using heavy water at low temperatures is highly developed; (6) ease of control by moving the moderator into and out of the core through simple valves; (7) safety in the event of collision or shipwreck; (8) superheated steam of all heat transfer liquids has the widest practical background; (9) the selected ratings and temperatures of fuel elements are conservative; (10) ease of manufacture; (11) materials unreactive with sea water, and coolant can be made up from ship's freshwater plant; (12) pressure-tube design permits scaling up to higher powers; (13) suitable for plutonium enrichment; (14) considerable development potential—the possibility of using a direct reactor-turbine circuit is being investigated.



(6301) "ENGINEERING"

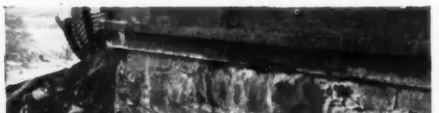
Data for VNE Steam Cooled HWR Plant

Reactor: pressure tube design
Moderator: heavy water in tubes at low temperature and almost atmospheric pressure
Reflector: light water
Coolant: dry steam in self-driving (thermo-compressor circuit
Moderator cooling circuit: heavy water (inlet temp 50° C, outlet temp. 90° C)
Reflector cooling circuit: light water
Fuel: uranium oxide pellets of low enrichment (19 rods per bundle with special finning)
Canning: stainless steel
Primary steam—inlet temp.: 500° F, 260° C; outlet: 970° F, 520° C
Control: raising and lowering the heavy water level in separate control tubes (helium on free surface)
Containment: aluminium calandria
Support structure: aluminium diagrids
Weight of plant (including containment and heat exchangers): 2,100 tons

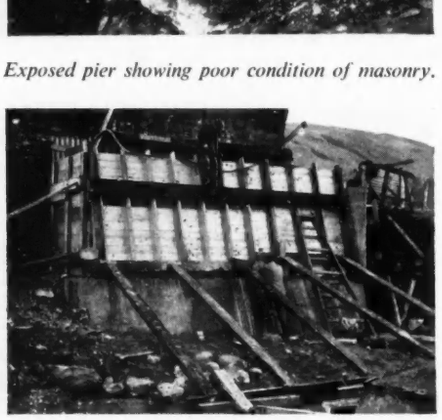
LOW PRESSURE GROUTING TO REPAIR UNDERWATER PIERS

Repairs to the piers of Cononish Viaduct, on the Scottish Region of British Railways, and from which all the mortar had been scoured by the river, have been accomplished using Intrusion Prepakt Concrete. This method was adopted because this concrete is well suited to work under water and for underpinning.

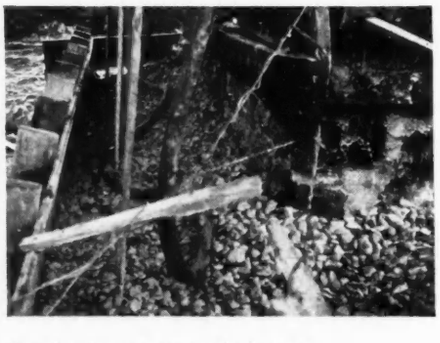
The viaduct is a four-span structure carrying the single line of the Callender and Oban branch over the River Cononish in Argyllshire. The two end spans are "dry" with the middle two spans, which are larger than those at the banks, bridging the river. As is shown in the top photograph, severe scour had caused bad undercutting below the central pier, and in the case of one of the other piers the earth banking had been swept away to expose poor quality masonry. The repair work comprised the construction of a concrete buttress to protect the exposed pier and the underpinning of the central pier.



Exposed pier showing poor condition of masonry.



Shuttering for second lift to buttress.



Grouting in progress on the buttress.

Underpinning of centre pier completed.

The preparation of Intrusion Prepakt Concrete involves filling the voids in coarse aggregate with mortar. To build a buttress, for example, coarse aggregate is placed inside the shuttering and thereafter Intrusion mortar is introduced through pipes within the aggregate. In addition to Portland cement, sand and water, the mortar contains fly ash and a proprietary additive which gives the mortar the properties of colloidal suspension, eliminating the effect of setting shrinkage and delaying early stiffening of the mortar. This last function is an essential part of the process as the mortar is pumped into the aggregate, at low pressure, and normal liquid flow carries the mortar into the voids in the aggregate. The fly ash is used as a cement replacement agent, and also assists in delaying the initial set and improving the flow characteristics.

Due to the poor condition of the masonry in the exposed pier it was decided to proceed with the construction of the concrete buttress first. Excavations and subsequent concreting were carried out in three sections, each section being completed before excavation commenced on any other section, in order to retain a measure of support for the pier throughout the work. The buttress was cast in two lifts, each about 8 ft in height.

Excavation began at the downstream corner of the pier and material was cleaned from the face of the pier to a depth of about 2 ft 6 in, whereupon the interior of the pier was flushed out with water jets and loose mortar raked from the joints. Grout mixes were prepared and pumped into the pier through the same points as the washing operations had been made. This cycle of operations was repeated until the excavation reached base rock, the object being to consolidate the pier prior to completing the removal of all material from around the base.

Shuttering was then erected about the downstream corner and the dry aggregate, graded from 9 in down to 1½ in, was tipped on to the bedrock which had been thoroughly washed free of clay to obtain a good key. When the shuttering had been completely filled with aggregate, grout was pumped in through tubes at 5 ft centres until the whole of the aggregate had been conglomerated into a concrete. The shuttering was stripped three to four days later.

In a similar manner the first lift of the buttress at the upstream corner and, finally, the first lift on the centre portion were completed. Shuttering for the second lift was then erected over the whole length of the buttress, filled with aggregate and grouted as before. The concrete buttress formed in this way has an excellent key into the base rock at the foundation and also into the masonry of the pier where the rough joints permitted the grout to flow into and bond with the pier.

Underpinning of the centre pier was done differently. Material excavated for the foundations of the buttress was thrown into the river where there was a pool 6 ft to 7 ft in depth between the two piers. This material consisted largely of good river gravel, clay and silt, and when thrown into the river the clay and silt were washed downstream and a clean aggregate settled to the bottom. The tipped aggregate filled the pool and was also packed into the scoured area below the pier. A timber shutter erected across the stream between the downstream end of the centre pier and the bedrock on the shore pier assisted in holding the aggregate in position.

Grout pipes were driven into the aggregate close to the centre pier, at about 3 ft centres; grouting operations commenced into the upstream injection point and progressed along a line of pipes to the downstream injection point. In this way the aggregate was conglomerated and the cavity below the centre pier filled with concrete.

Two points about this method of construction are worthy of note. As the setting shrinkage of this type of concrete is virtually nil, it is well suited for use in underpinning work and particularly for underwater work of this type. Secondly, as the aggregate may be deposited directly behind the shuttering the volume of material which requires to pass through the batching and mixing plant is reduced to about one-third or at most one-half of that required for a concrete mixed in the conventional manner.

The work was carried out under the chief civil engineer, Scottish Region, British Railways, in close collaboration with Millars' Machinery Company Limited, Bishop's Stortford, Hertfordshire.

HULL BRIDGE OPPOSITION WITHDRAWN

All petitions lodged against the Humber Bridge Bill have been withdrawn. This means that the Bill is likely to have a straight run through both Houses of Parliament, which would then allow the bridge board to be formally established. A substantial Treasury grant will be required before construction commences and, say the Humber Bridge Committee, the amount given will affect the toll scale imposed.

The bridge would be the longest single-span bridge in the world, being 4,536 ft between piers, one of which will be in the river itself. Clearance below the bridge is now to be 97 ft.

CAPITAL WORKS IN KHUZESTAN

In 1955 Iran adopted a second seven-year Plan which involved spending $1,100 million gained from oil revenues to build hospitals, schools, communications and water control projects. Emphasis was laid on re-establishing the productivity of the south-western Khuzestan region and the American firm, Development and Resources Corporation of New York, were called in to assist.

The programme now under way has three primary features. First, the rapid execution of public works—dams, power plants and irrigation systems. Second, the active encouragement of private Iranian and foreign investment to make use of these works. And third, the training of young Iranians to become the managers and operators of Khuzestan's new acquisitions; this aspect is being treated as fundamental to the Plan. To carry the Plan through the Corporation have been allowed to assume an unusual degree of managerial discretion.

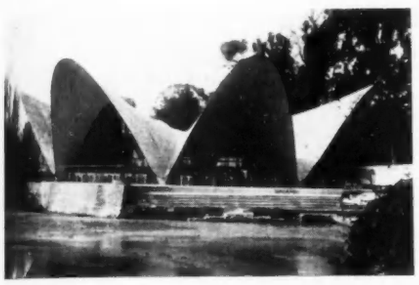
The capital works now in hand represent an investment of more than $100 million. Foremost is the Dez project, a combined hydroelectric and irrigation scheme that will have an ultimate capacity of 520 MW and provide water to irrigate 362,000 acres. By 1973 agricultural production is expected to increase fourfold. Electric power lines are being erected between Abadan and Ahwaz and two more lines are planned. At Ahwaz a pvc plant is to be based on the rich oil and gas fields in the region. Agricultural projects include cane sugar production—30,000 tons a year by 1963—and a fertilizer programme that also includes the education of the farmers and smallholders in the use of fertilizers.

CANDELA'S SHELLS

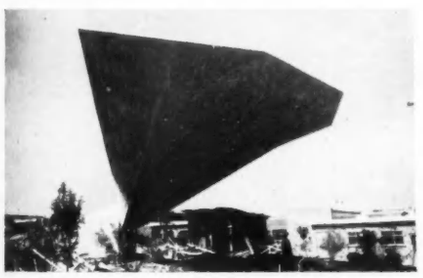
Professor Felix Candela, the eminent Mexican architect-engineer, has been lecturing at a number of centres in the United Kingdom on his philosophy of building and the evolution of his style, particularly his use of anticlastic shells. His lecture, which was illustrated by numerous slides, was sponsored by the Joint Committee on Structural Concrete, and full copies of his remarks can be obtained from the Cement and Concrete Association. An illustrated review of his work was given in *Concrete Quarterly*, No. 33, for April, 1957.

Candela was trained as an architect in Spain but is now in business as a builder in Mexico. He believes—like others—that the elastic theory and the engineering approach based on detailed calculation has stifled development. Working in Mexico, however, there was ample opportunity to experiment. His clients, he said, " were not particularly worried about the form their structures take, so long as it was economic." His own method was to copy the work of others —he had never been afraid to copy; if he saw something he liked he built something similar, making only small changes and learning gradually by experience.

Vaults, barrels and other singly curved surfaces were not true shells—they were better termed " laminar " structures. A true shell withstood stresses in the surface without any bending



Bandstand—of hyperbolic paraboloids.



Restaurant—of intersecting " saddle " vaults.

and for such action must be doubly curved. There were two fundamental types of doubly-curved shell: the synoclastic with curvature always in one direction (like a dome) and anticlastic in which curvature was upwards in one direction and downwards in the other (saddle-shaped). The latter were particularly interesting because they were defined by two systems of straight generators which enabled a simple pattern of shuttering to be adopted. The form which appealed most to Professor Candela was the hyperbolic paraboloid—the " warped " parallelogram. By illustrations he traced the development of his umbrella shells formed of four simple anticlastic shells side by side and supported off a single central column. Very practically he had also inverted the umbrella to form an effective foundation for very poor soils. Two quite typical Candela structures are shown in the accompanying illustrations.

Motorway Construction in Europe

During 1958 motorways opened to traffic in Europe totalled 283 miles, including 80 miles in Germany, 78 miles in Austria, 20 miles in Belgium, 75 miles in Italy and 20½ miles in the Netherlands. In the United Kingdom, 6¾ miles were opened.

Work is under way in Czechoslovakia on the country's first superhighway linking the two ends of the country, including Prague in the west and Kosice 750 miles away to the east. The first 127 miles, from Prague to Humpolec, has been finished. Completion of the whole projected highway is expected about 1970.

In France the 1959 budget sets aside £7·8 million to eliminate blind curves and to provide cyclists' tracks. £1,325,000 is provided as France's share of this year's work on the Mont Blanc tunnel (see ENGINEERING for April 17 last). The total road budget for the year is 25,000 million francs (£18 million) and the road fund expenditure is to be 10,800 million francs.

Between Naples and Capua, in Italy, another 25 miles of the " Highway of the Sun " has been opened. Construction on 50 miles of the Florence to Rome motorway is to be begun and plans for the Rome to Capua (75 miles) section have been approved. Work is to start a year ahead of the original schedule.

Building Problems in Canada's Far North

A new technical report " Building in Northern Canada " has been published by the Division of Building Research of the National Research Council, Ottowa. The report, 75 cents a copy, is 50 pages long and mimeographed. It has been compiled to answer inquiries which the Division has been receiving about the special features of building in the Canadian North.

Climate is not the most significant factor. Logistics and economics are the chief determinants in northern building—one chart shows the increasing number of days without daylight as the northern extremities of the country are approached. The effects of permanent frost on buildings is discussed at length.

Measurement of Large Water Flows

Four methods are commonly used for measuring large water flows such as are involved in the acceptance tests for hydroelectric plant, pumping installations and water conservation schemes. They are: current-meter measurements, the salt-velocity method, the salt-dilution method, and pitot-tube traverses.

These four methods were all examined at the former Mechanical Engineering Research Laboratory (now to be known as the National Engineering Laboratory) at East Kilbride, and improvements found. The proposals are outlined in a *Fluid Report*, " Measurement of Large Water Flows," issued from the laboratory and a bibliography gives details of references where more detailed reports are to be found describing the proposals.

Traffic Engineering Fellowship

A fellowship in traffic engineering, tenable at King's College, University of Durham, has been made possible by a grant of £500 per annum for three years until 1962 from the Trustees of the Rees Jeffreys Road Fund.

The Fellowship will be held by postgraduate students working in the Traffic Engineering Section of the Department of Civil Engineering. The first award will be available from October, 1959, and applicants should have a degree in civil engineering or an equivalent qualification. In charge of the department is Dr. T. E. H. Williams who has recently returned from spending a year as visiting Professor in North-western University, Illinois, where in addition to teaching he carried out research on Chicago's traffic. An article by Dr. Williams describing a field study of Newcastle upon Tyne's traffic problems was published in ENGINEERING vol. 186 p. 480, 10 October, 1958.

Shifting Coal Stockpiles

The Marshall Organisation has made a special U-blade for coal handling which is matched to their Fowler Challenger 33 crawler tractor. At a recent demonstration at Hams Hall Power Station, Birmingham, a tractor so equipped gathered 412 tons of pulverised coal from the stockpile to conveyor hopper in 1 hour; the average haul was 200 ft.

The use of mobile plant, such as tractors, rather than fixed and semi-fixed gantries, is a feature for new power station and steelworks operation. Lower capital costs are usually involved and a higher plant utilisation can be achieved.

Whitstable Industrial Estate

A new industrial estate, of about 22 acres facing on to the Thanet Way, is to be established at Whitstable in Kent. Factory sizes will range from 200,000 sq. ft to as little as 5,000 sq. ft. Where necessary Treasury assistance may be given towards projects that will absorb local labour.

By train Whitstable will be brought within 65 minutes of London by the new electrification of the Southern Region. The local council have recently completed a new dock for 1,000 ton vessels which will provide cheap connections around the coast and to the Continent. Nearby Manston airport has been scheduled for civilian traffic. By road, the Maidstone bypass will be ready in 1962 and the Medway bypass by 1963. In 1962 the Purfleet tunnel under the Thames will be opened, providing a fast route to the Midlands and the North.

British Railways Contracts

Among the contracts recently placed by British Railways (London Midland Region) are the following. Piling and foundations at Cricklewood lightweight and main-line diesel engine depot have been let to West's Piling and Construction Company, Limited, Harmondsworth, Middlesex. The reconstruction of the superstructures for a bridge on the Leicester and Trent line and another between Betley Road and Crewe are to be undertaken by the Butterley Company Limited of Derby.

The North-Eastern Region have ordered some fabricated steelwork for temporary girders for bridgeworks from Thos. Storey (Engineers) Limited, of Stockport; and the Cooper Bridge No. 182, now an arch structure, is to be replaced by a steel girder bridge built by Wellerman Brothers Limited, of Sheffield.

On the Southern Region strengthening of the banks and new drainage work at Bickley Junction is to be undertaken by George Wimpey and Company Limited. The Cementation Company Limited are to do the foundation piling for Sherbourne signal box and at Ashford, Kent, new electrical repair shops and other buildings are to be erected by John Mowlem and Company Limited.

New Tagus Bridge at Lisbon

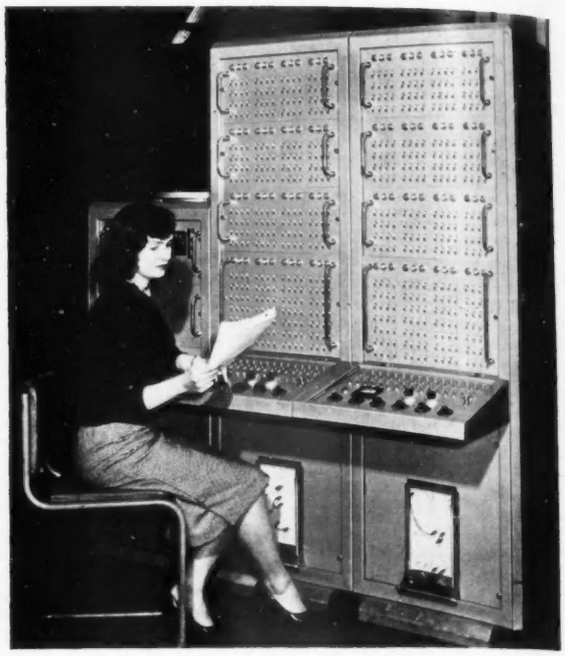
An open competition for a new bridge over the Tagus at Lisbon has been announced. The entries have to reach the Gabinete da Ponte Sobre o Tejo, 77 Avenida Duque de Loulé, Lisbon, by 27 February, 1960; details may be obtained from the same office.

ELECTRONICS IMPROVE MOTORING

Analogue Computers Solve Design Problems

The electronics laboratory of A. V. Roe and Company Limited, a member of the Hawker Siddeley Group, whose normal business is to design electronic computers to solve aeronautical engineering problems, have now turned some of their attention to the problems of motor car design. Initially they have decided to direct their effort toward computer techniques for designing suspension systems, but there is every reason to suppose that similar techniques may be adopted for other car design problems in the near future.

Tests to find the right combination of spring and damper usually involve many months of painstaking work on tracks and roads and, even then, they are not always sufficient to give the best results. Because of these drawbacks to traditional methods of research, the analogue computer technique represents an important step forward, both to improved design and to eventual cost reduction. With this device many design possibilities may be explored in the laboratory, while the car is still on the drawing board, resulting in the first prototype model having near perfect suspension.



Electronic computer to be used for the solution of suspension design problems.

The computer used in this work is a form of electrical analogue which solves dynamic equations describing the motion of the system in question. The car designer first sets up on potentiometers, electrical values corresponding to such design features of the car as weight, distribution of load, stiffness of springs and tyres, damper characteristics, rolling radius of wheels, position of centre of gravity, etc. Circuits of the computer are then given an electrical input which represents road surface irregularities e.g., in the case of running up a kerb, a " step " voltage input is applied. Electrical signals then circulate within the computer circuits and the voltages at different points correspond to and vary in the same way as the dynamic quantities in which the car designer is interested, such as pitching of the car, rolling, tyre deflections, and spring deflections.

AN END TO TRAVEL SICKNESS

One of the advantages of tackling design problems with a mathematical approach is that certain factors, for which mathematical equations have already been established, may be dealt with in the laboratory, without resort to extensive empirical investigations. One such study is that of travel sickness.

It has been scientifically established that the most common form of travel sickness occurs when the motion of the vehicle is of a certain frequency and amplitude. If, therefore, it were possible to design suspension systems so that the car did not approximate to these conditions, travel sickness could be almost eliminated. The analogue computer will greatly assist the car designer in avoiding these critical motions, since he will be able to detect their occurrence long before the first prototype has been constructed.

After setting up the programme, the operation of the computer is simple. The operator has merely to select on a switch what it is that he wants to look at and the machine feeds out the appropriate record; he need not be highly skilled. Should the operator wish to explore the effect of changing springs or dampers or weight of the vehicle, he has simply to change the settings of one or two potentiometers and repeat the calculations. Thus, in a matter of one or two hours, he is able to completely explore the design possibilities of a suspension system. He may also investigate the margins of safety more thoroughly since there is no danger resulting from trying out unusual design features.

The computer itself does not of course design suspension systems; but in the hands of an experienced engineer it can be a powerful tool, replacing much experimental work and leading to design improvements that otherwise could not be achieved. From the car stylists point of view it means that they can expect a much more sympathetic hearing to their ever changing demands, since the engineers can quickly check the effects on ride and stability when changes in body shape are suggested.

ROAD ACCIDENTS *What Remedy?*

The experience of three European countries—Belgium, the Federal Republic of Germany, and the Netherlands—appears to show that the introduction of speed limits results in a considerable drop in the number and seriousness of road accidents. These findings were reported at a session of the working party on the prevention of road traffic accidents of the Inland Transport Committee of the United Nations Economic Commission for Europe, held at Geneva from 6 to 10 April this year.

In Belgium the limitation of speed to 70 km.p.h. (44 m.p.h.) outside built-up areas for two months has brought about a reduction of 8 per cent in the accident rate and of 17 per cent in the number of persons killed or seriously injured. In the Netherlands the imposition of a uniform speed limit of 50 km.p.h. (31 m.p.h.) in almost all built-up areas has reduced the number of persons killed by 16·8 per cent. In Western Germany the imposition of a similar speed limit in all built-up areas has reduced the number of persons killed by 18·1 per cent and the imposition of a speed limit of 100 km.p.h. (62 m.p.h.) on the Frankfurt/Mannheim motorway has reduced the number of accidents by 50 per cent. However the significance of this figure is obscured by the fact that safety conditions on this highway were at the same time improved by other means.

These results seem almost too good to be true. If a mere tightening of the speed restrictions can do so much to prevent injury and loss of life then surely action should immediately be taken to reduce speed limits here. But, on second thoughts, would this really be the right approach to the problem? Surely if bad drivers are on the open road, they can kill just as effectively (if not quite as often) at 50 m.p.h. as at, say, 70 or 80 m.p.h., which is the top speed for the majority of motor vehicles anyway. We already have a speed limit for built-up areas, and rightly so, but still a great many accidents occur and if excessive speed is the major cause, then surely stricter enforcement of the existing speed limit should be implemented rather than any reduction in that limit.

Arguments about the causes of and the remedies for the appalling number of road accidents that occur seem to go on and on, consuming time and money, while the accident toll continues to increase. Is it not about time that we got right down to fundamentals on this matter? Should not we put far more effort into doing everything possible to keep bad drivers off the road, either by stricter driving tests or by periodic retesting, or even both?

NO MORE STANDARD CARS? *By Gordon Wilkins*

The 948 cc Triumph Herald replaces the Standard 8, Standard 10 and Standard Pennant, and from now on only one of the small Standards will remain in production, the Standard 10 station wagon. For some time small Standards have been sold with different badges in the United States under the name of Triumph, and the Standard Pennant with more luxurious finish and an anti-roll bar added at the front has been sold in Eire as a Triumph Pennant. Are we therefore about to see the end of Standard as a separate make? I put the question to Mr. Mike Whitfield, Sales Director of Standard-Triumph, who replied, " The management of our assembly plants can always arrange these things in the way which best suits their particular market, but it seems possible that there will be no new Standard models for export. It is essentially an export problem."

Standard, one of the great names of the British industry since 1903, signifies for most of us the national flag, and the emblem of the make is the Union Jack. But for the Americans " standard " signifies a cheap model with the minimum of equipment and no luxury features. Market investigations showed that the name Triumph was far more acceptable in the United States. It is therefore the Americans who have tolled the knell of the British Standard and it seems probable that the 2-litre Vanguard III and the 1,670 cc Ensign will be the last models to carry this honoured name.

BLADE FREQUENCY OF TURBINES

Effect of Disc Elasticity

By J. P. ELLINGTON, B.Sc., A.M.I.Mech.E., UKAEA Risley

and H. McCALLION, Ph.D., A.M.I.Mech.E.,

Department of Mechanical Engineering, University of Nottingham

The frequency equation for a model of a turbine disc and blading is derived and discussed, and it is shown that the frequency spectrum of the system consists of an infinite number of bands of frequencies, in practice the frequencies in these bands being close to those of a cantilever.

A full understanding of the vibration characteristics of turbine or compressor blading, discs, and rotors is obviously of great practical importance, and the study of these vibrations has been the topic of many researches. As a result, theoretical work on some elements is firmly based on practical knowledge, and the frequencies and modal shapes of a turbine blade or disc can be forecast and measured with a high degree of confidence.

However, although many experimental studies of actual disc and blading systems have been carried out, theoretical work on the combination of the two does not seem to have so developed, it being usual to consider the disc and blades as separate entities. While this approach may be reasonable in many cases it may be a grave source of error, especially in the interpretation of vibration tests, and the purpose of this note is to indicate the possible effects of mechanical coupling on the natural frequencies of blades attached to an elastic disc.

At first sight it would appear that if a number of identical blades all having the same natural frequencies were attached to the rim of a disc then each blade would vibrate at its own natural frequency independent of its neighbours. This is not the case, however, and as will be shown below, unless the rim of the disc is absolutely rigid, the blading does not possess a fundamental frequency but bands of fundamental frequencies, nor higher harmonics but bands of harmonics. In a similar manner the modes of vibration of the blading are not random but are related to their particular frequencies as in the normal theory of vibrations of continuous systems.

The result is that in a vibration test, even when all the blades are identical, there is likely to be what has been termed a frequency scatter, and as reported in the experimental work of Andrews and Duncan[1] there will be a range of resonant states, with what they call fully and partial resonant conditions.

This state of bands of frequencies is not unknown in turbine blade systems, it has been pointed out by Smith[2] in connection with the vibration of blades fitted with shrouds or lacing wires. The authors[3] have put Smith's equations into a form more suitable for computation, and in a packet of turbine blades laced at their tips it can be shown that in addition to the modes corresponding to the fundamental and overtones of an end-loaded cantilever there exist between these frequencies bands of frequencies with mode shapes having little or no displacement of the blade tips. Andrews and Duncan, in their work on packets of laced blades, unfortunately confined their results to the fundamental modes of flexural and torsional oscillations and so do not report these additional frequencies. However, experimental work on similar systems is being undertaken in the Department of Mechanical Engineering of the University of Nottingham with a view to confirming these results.

To return to the problem of the blades and disc, the only theoretical work seemingly available is a consideration by Johnson and Bishop[4] of a system consisting of a large number of identical and parallel mass-spring elements attached to a large rigid mass. This system has a large number of equal frequencies with arbitrary principal modes subject to the restriction that these modes are orthogonal among themselves, but while suitable principal modes are found the effects of elastic coupling through the large mass are not discussed.

In this note then the effects of elastic coupling, through the rim of the disc, on the frequencies and modes of vibration of the blading will be considered by means of a simple model. While this model is not entirely suitable for computation of actual systems it should be of service in the interpretation of test results and in guiding further work on this rather complex topic.

MODEL DISCS AND BLADES

To simplify the analysis, the actual turbine blades are replaced by a set of uniform parallel blades fixed to the discs at their roots and vibrating in a principal plane parallel to the rim of the disc. This means that the effect of twist, taper, and obliquity of the blading is not taken into account, but this should not seriously affect the results given below.

The rim of the disc is then imagined as a uniform elastic ring held so that no radial motion of the roots of the blading is possible, and in addition the mass of the rim is neglected, or taken as being "lumped" at the roots of the blades. This particular representation is very suitable in that the static equations for bending can be applied to the portions of the rim between blades, and although more sophisticated models of the system could be taken to give a slightly better picture of the elastic coupling and to allow for the distributed mass of the rim, very little further information is gained at the expense of a considerably increased analysis.

Considering a portion of the rim and its blades, as shown in Fig. 1, then if each blade is

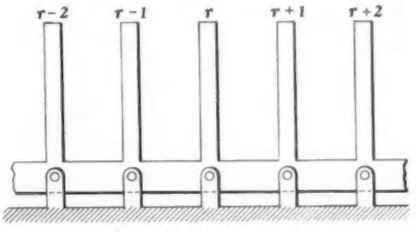


Fig. 1 Portion of turbine rim and blades.

of length L, weight per unit length w, and flexural rigidity EI, the deflection y, at a distance x from the root, when vibrating at a natural circular frequency, is

$$y = A\cos\lambda x + B\sin\lambda x + C\cosh\lambda x + D\sinh\lambda x \quad (1)$$

where

$$\lambda^4 = w\,\omega^2/g\,EI \quad . \quad . \quad . \quad (2)$$

Now at the root of the blade, where $x = 0$, there is no deflection but there is a bending moment, M, in a positive direction, as shown in Fig. 1:

$$y = 0 \text{ and } M = EI\,y''$$

so that

$$A = -C = -M/2\,\lambda^2 EI$$

Since the blade tips are free there is no bending moment or shear force at $x = L$ and

$$y'' = y''' = 0$$

giving

$$B = \frac{A(1 + \cos\lambda L\cosh\lambda L + \sin\lambda L\sinh\lambda L)}{(\cos\lambda L\sinh\lambda L - \sin\lambda L\cosh\lambda L)}$$

and

$$D = \frac{A(1 + \cos\lambda L\cosh\lambda L + \sin\lambda L\sinh\lambda L)}{(\cosh\lambda L\sinh\lambda L - \sin\lambda L\cosh\lambda L)}$$

From equation (1) the relationship between the bending moment and the slope of a blade at its root is given by

$$\theta = \frac{dy}{dx} = \lambda(B + D)$$

$$= -\frac{M}{\lambda EI}\,\frac{(1 + \cos\lambda L\cosh\lambda L)}{(\cos\lambda L\sinh\lambda L - \sin\lambda L\cosh\lambda L)}$$

Using the notation of Bishop and Johnson's[5] *Vibration Analysis Tables*, this equation may be written as

$$\theta = -(M/\lambda EI)\,(F_4/F_5) \quad . \quad . \quad (3)$$

where $F_4 = 1 + \cos\lambda L\cosh\lambda L$,

$F_5 = \cos\lambda L\sinh\lambda L - \sin\lambda L\cosh\lambda L$,

etc., the F's being tabulated functions.

The static equations for bending of a uniform beam are then taken as applicable to the rim of the disc, and the bending moments in the rim to the left and right of the rth blade are

$$\left.\begin{aligned} m_r^{L} &= \left(\frac{E_1I_1}{L_1}\right)(4\theta r + 2\theta r - 1) \\ m_r^{R} &= -\left(\frac{E_1I_1}{L_1}\right)(4\theta r + 2\theta r + 1) \end{aligned}\right\} \quad (4)$$

where E_1I_1 is the flexural rigidity of the rim and L_1 is the pitch of the blades.

For equilibrium at the root of the rth blade shown, the algebraic sum of the moments is zero there, and

$$M_r - m_r^{L} + m_r^{R} = 0$$

and on using equations (3) and (4)

$$0 = -\lambda EI\left(\frac{F_5}{F_4}\right)\theta_r - \left(\frac{E_1I_1}{L_1}\right)(2\theta_{r+1} + 8\theta_r + 2\theta_{r-1})$$

$$= \theta_{r+1} + \left(4 + K\,\frac{\lambda L}{2}\,\frac{F_5}{F_4}\right)\theta_r + \theta_{r-1} \quad (5)$$

where K is the stiffness ratio of blading to rim,

$$K = \frac{EI}{L}\Big/\frac{L_1}{E_1L_1} \quad . \quad . \quad (6)$$

Equation (5) is a homogeneous, second-order, linear difference equation and as in the case of linear differential equations may be solved by assuming a suitable solution,

$$\theta_r = A\exp(\phi r)$$

where A is some constant and ϕ is to be deter-

mined. Substitution in equation (5) gives

$$0 = \exp(\phi) + \left(4 + K\frac{\lambda L}{2}\frac{F_5}{F_4}\right) + \exp(-\phi)$$

or

$$\cosh\phi = -\left(2 + K\frac{\lambda L}{4}\frac{F_5}{F_4}\right) \quad . \quad . \quad (7)$$

This is the characteristic equation, giving two roots $\pm\phi$ which satisfy equation (7) so that the complete solution of equation (5) is

$$\theta r = P\cosh\theta r + Q\sinh\theta r \quad . \quad (8)$$

BOUNDARY CONDITIONS AND FREQUENCY EQUATION

To solve for the constants P and Q, it is necessary to substitute equation (8) in the boundary equations of the system. Taking a total number of (N + 1) blades if we take one blade to be the origin for r, $r = 0$, then the Nth blade is adjacent to the origin, as shown in

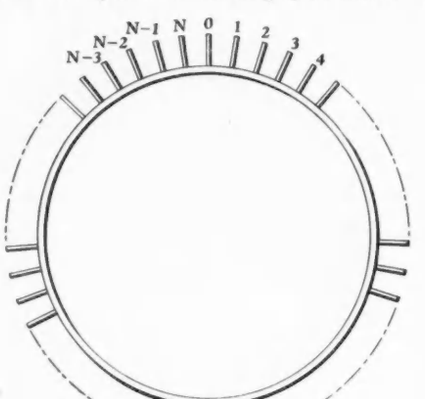


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Fig. 2 Notation for blading.

Fig. 2, and the equilibrium equation (5), for $r = 0$, becomes,

$$\begin{aligned} 0 &= \theta_1 - 2\cosh\phi\,\theta_0 + \theta N \\ &= P\cosh\phi + Q\sinh\phi = 2P\cosh\phi \\ &\quad + P\cosh\phi N + Q\sinh\phi N \\ &= P(-\cosh\phi + \cosh\phi N) + \\ &\quad Q(\sinh\phi + \sinh\phi N) \quad . \quad . \quad (9) \end{aligned}$$

In a similar manner the equilibrium equation for the Nth blade is

$$\begin{aligned} 0 &= \theta_0 - 2\cosh\phi\,\theta N + \theta N - 1 \\ &= P - 2\cosh\phi(P\cosh\phi N + Q\sinh\phi N) \\ &\quad + P\cosh\phi(N-1) + Q\sinh\phi(N-1) \\ &= P[1-\cosh\phi(N+1)] - Q\sinh\phi(N+1) \quad (10) \end{aligned}$$

Eliminating P and Q from equations (9) and (10) gives the frequency equation

$$0 = 2\sinh\phi + \sinh\phi N - \sinh\phi(N+2).$$

Writing $\sinh\phi N = \sinh[\phi(N+1) - \phi]$ and $\sinh\phi(N+2) - \sinh[\phi(N+1) + \phi]$ this equation becomes

$$0 = 2\sinh\phi[1 - \cosh\phi(N+1)] \quad . \quad (11)$$

For equation (11) to hold we must have $\cosh\phi(N+1) = 1$, and so ϕ must be zero or an imaginary quantity, with $\phi(N+1)$ having the values $0, 2\pi i, 4\pi i$, etc., giving

$$\phi = i\frac{2p\pi}{N+1} \quad . \quad . \quad (12)$$

Returning to equation (7) the frequencies of vibration are found as the solutions of

$$\lambda L\frac{F_5}{F_4} = -\frac{4}{K}\{2 + \cos[2p\pi/(N+1)]\} \quad (13)$$

Permissible values of p are 0, 1, 2, 3, . . . N, the values $p = (N+1), (N+2), (N+3)$, etc., merely repeat values given by $p = 0, 1, 2$, etc.

The graph of $(\lambda L F_5/F_4)$ in Fig. 3 shows an infinite number of branches corresponding to fundamental, first overtone, etc., frequencies while to each branch there exist N frequencies corresponding to the value of p given above. Thus, the effect of the elastic coupling of the roots is that there exists, (N + 1) fundamental frequencies, (N + 1) first overtones, etc.

Practical values of K, the ratio of the blade to rim stiffness, are likely to be small, and, in the limit, as K tends to zero then $F_4 = 1 + \cos\lambda L\cosh\lambda L$ also tends to zero giving the frequency equation for a uniform cantilever. The N + 1 frequencies in any one band are thus likely to be very close to one another, this possibly being an explanation for the " scatter " found in vibration tests in that unless excessive accuracy of control is used it is likely that different modes are excited by small changes in the exciting frequency.

With the values of ϕ given by equation (12) inspection of equation (10) shows that the values of P and Q are arbitrary and depend upon the way in which the motion starts, so that in general the slope at the root of a blade

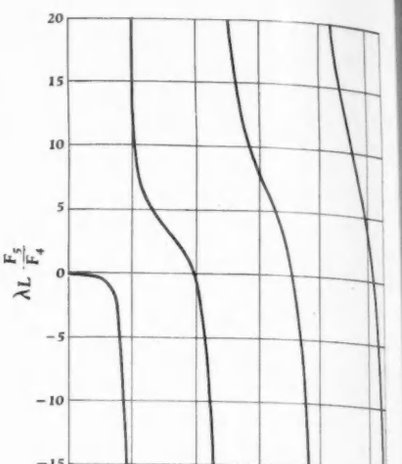

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Fig. 3 Branches correspond to fundamental and overtone frequencies.

is given by

$$\theta_r = \sum_{0}^{N} P_p \sin[2p\pi r/(N+1) + \psi_p] \quad (14)$$

where P_p is some constant and ψ_p is a phase angle. While this gives the motion at the root of the blade at other points on the blade it is also necessary to know on which branch or branches of the $(\lambda L F_5/F_4)$ curve the motion is taking place.

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RESEARCH ON DESIGN *Defining Criteria of Taste*

The question of what is good design is not one that can be answered one way or another. " Beauty is in the eye of the beholder " is true enough and the success of the designer depends on getting other " beholders " to agree with his particular idea of beauty. Last year the director of the Institute of Design of the Illinois Institute of Technology tried to find out whether designers agreed among themselves on what were the 100 best designed mass-produced products of modern times. A hundred leading designers, architects, and design teachers were asked to name their top ten designs. The answers of the 80 or so of them who replied were analysed in the April issue of *Fortune* magazine. The products mentioned have been listed from 1 to 100 according to the votes each obtained.

One of the problems of an exercise of this sort is to define the criteria on which the selection is to be made. In this case the guinea pig designers were simply asked to say what they thought. As a result some very odd selections were made. Perhaps the strangest is the Franklin Stove which Benjamin Franklin knocked up about the year 1750. This and the Model T Ford of 1923, and the Victor Talking Machine of 1901 have clearly been selected as forerunners of later designs. Other products have come in on purely aesthetic grounds, and a few because of mechanical excellence.

The number one design with 55 votes is the Olivetti Lettera 22 portable typewriter, first produced in 1950. Then follows two chairs by American designers and the Studebaker hard-top coupe of 1953. Number five is the Parker 51 pen designed in the United States but manufactured by subsidiaries in many countries. The Lincoln Continental 1940 designed by Edsel Ford and E. T. Gregorie of the Ford Motor Company, completes the first six.

The first British product on the list is the Raleigh bicycle sports model of 1925 which comes at number twenty five. So far as Britain is concerned there is then a long gap down to number 76, the BSA motorcycle Super Rocket Model of 1956. Close behind it number 79 is the Rolls-Royce Phantom II Mulliner Continental Tourer of 1930. The only other British product is the MG Model TC of 1948, which is 89.

Not surprisingly, the United States has most products in the hundred selections. They include six cars apart from the Model T. The Ford Thunderbird of 1955, adds to the mystery of who it is that likes the long low wide chromium-plated look. Italy is the best represented foreign country, with seven products. Two of these are by Olivetti, others are the Vespa 125 cu. cm scooter of 1956, Farina's Cisitalia Gran sport saloon car of 1946, the Necchi Mirella sewing machine of 1955, the Borletti sewing machine of 1956 and just to show how versatile the Italians are the Ponti toilet set of 1954. Germany has six products in the list. Two cars, the VW Karmann-Chia Coupe of 1955 and the Porsche 1500 Super of 1952, Paul Renner's Futura typeface of 1957, the Luger Standard Army 9 mm pistol of 1908, the Leica IIIc camera of 1940 and the Arzberg white china set of 1931. Other products from Europe are the Citroen DS-19 of 1955, various chairs from Finland, Sweden, Denmark and Austria, and the Hermes Rocket portable typewriter of 1932 from Switzerland.

It is very obvious that in a selection of this sort which includes everything *and* the kitchen stove there will be a number of items that would not have got into a more homogeneous list. Even so, it is very interesting to see what the 100 best designers think are the 100 best designed products. But why are the two items most frequently mentioned motor cars and chairs. There seems to be scope for some work by the motivational research men here.

FUELLING JET AIRLINERS

Shell Research Solves Problems of Fast Flowing Fuels

Modern research methods are playing an increasingly important role in the many new problems connected with the rapid, economic and safe fuelling of the huge jet airliners now being introduced on the world's airlines.

Two major problems have arisen simultaneously. The increase of traffic on the airfield, which limits the manoeuvrability of fuel-carrying tenders; and the increased tank capacity of the new airliners, which must be filled at initial rates of about 1,000 gallons per minute in order to keep ground time to a minimum.

In turn, these problems have given rise to several others. To solve these the main focus of attention at the Shell laboratories has been directed toward improving basic fuel purity, automatic monitoring, dispersion of static electricity and the development of improved hydrant systems to eliminate the need for fuel tankers on the airfield.

This work is being carried out at the Thornton Research Centre of Shell Research Limited, Thornton-le-Moors, Cheshire.

Aircraft being refuelled by hydrant. The dispenser being used is the newly developed Apex, which can be operated entirely by one man and can deliver 150 gallons per minute.

Fuel Purity

This is probably the major part of the research programme, since no standard of purity can ever be too high for the safety, performance, and economic maintenance of modern civil aircraft engines. Liquids which appear to be perfectly clean often contain minute quantities of tiny solid particles. These small concentrations, when related to a fuel consumption of some 16,000 gallons for the new jet airliners, could result in the introduction of intolerably large amounts of solid particles into the aircraft engine's fuel system if left unchecked. To ensure that clean and water free fuel is supplied to aircraft, whatever the rate of fuelling, the Shell quality control laboratories have investigated a number of techniques and different types of filter equipment.

One such piece of equipment is the microfilter, which is the final safeguard against contaminated fuel entering the aircraft. This item has been the subject of intensive study at Thornton and work is now in progress to reduce the amount of solids in the fuel to a minimum and to ensure that very few particles bigger than one or two microns remain in the fuel.

Methods of analysing the performance of filters have been developed. To this end a full scale filter testing rig has been constructed by means of which, over relatively short tests, Shell are able to evaluate the efficiency of the filter in checking the flow of dirt, the capacity of the filter to handle large quantities of dirt and the relative life capacities of different filters.

The tests are carried out by running fuel through the filter at rated conditions, and introducing into this fuel an artificial test contaminant consisting of specially selected powders with particles varying in size from two to two hundred microns. During these tests, samples are drawn from both the influent and the effluent of the filter and compared in the laboratory in terms of solid content and the distribution of particle size. A number of special laboratory methods have been developed for the evaluation of microscopic material and, in particular, the visual method of counting has been replaced by a Casella electronic particle counter and sizer machine. This results in a count of some hundred thousand particles of sizes from one micron upwards. Each sample, which is mounted on an inspection slide, is traversed several times at different circuit settings to give a count for each of the different size groups. The complete count of a sample takes about one hour, excluding computing time and slide preparation.

Hydrant test rig viewed from the control room. Two of Shell's latest dispensers can be seen on the right of the picture.

Water Contamination

The problem of ice being formed on very fine engine filters by minute amounts of water is now generally recognised. Although modern turbine engined aircraft are equipped with fuel heaters, or similar devices, the amount of ice formation with which they can cope is quite limited. The fuel supplied to the aircraft on the ground can only be free from water to the extent of removing the undissolved water impurity and this has been the aim of the work which has been carried out at Thornton.

In respect of undissolved water, the kerosine type of aviation turbine fuel has presented a greater problem than the more volatile fuels, by reason of its higher viscosity and gravity which causes the water to be held in dispersion much longer. For the elimination of dispersed or free water from fuels, settling-in tanks and floating suction devices have proved effective, but alternative methods (e.g. water separators) are now being made available and one of the studies at Thornton is to determine how effective they would be in the field and the extent of their reliability.

Evaluation of water separators is being carried out on similar lines to the filter test procedure, except that water is inserted into the test fuel. Influent and effluent samples are compared in order to determine the degree of separation achieved. Shell's requirement is that no detectable free water should exist in the effluent from such equipment.

Automatic Monitoring

In spite of the number of checks that are made to ensure that the fuel delivered to an aircraft is free from contamination, the human element still remains as a weak link in the chain. To eliminate this, Shell have developed an automatic device which, when inserted in the feed line, will monitor the fuel quality and automatically shut down the flow if impurities, such as water or grit, are present in the fuel.

The fuel monitor, as it is called, comprises a valve and an element which is sensitive to

contaminants, the latter being so constructed that it will cause the main valve to close if contaminated fuel passes through it. During normal operation with clean fuel the monitor valve will open and close with the delivery valve so that it is repeatedly exercised, thus almost eliminating the risk of it becoming stuck in the open position. It is also constructed so that faulty maintenance, such as failure to replace the monitoring element, will prevent the valve from opening. The fuel monitor is about to undergo extensive field trials and, when these tests are complete, it is expected that it will become a standard piece of fuelling equipment, such as the well known water detector which was developed at Thornton a few years ago.

Main building of the Shell research centre of Thornton-le-Moors, Cheshire.

Static Electricity

Always a possible danger, when fuels are flowing rapidly through a paper filter, such as a microfilter, is the generation of powerful electric charges. The electric charges may be carried with the fuel and delivered to the aircraft tanks so that over the entire fuelling operation a large amount of charge may be collected in the tanks. If the charge is unable to disperse to the earthed sides of the tank, because of the low conductivity of the fuel, a strong field may develop in the vapour space and provide enough potential for a spark to pass. This is believed to have been the cause of some explosions at oil refineries.

In Shell's fuelling operations so far, no real trouble from static electricity has been experienced, mainly because the flow rates have been relatively low. However, looking to the future when large jet airliners will require much higher flow rates than ever before, Shell have been investigating the possibility of static electricity becoming a serious problem. So far their findings show that even at the highest flow rates yet achieved there is still a fairly large safety margin and the likelihood of an explosion occurring remains remote.

In addition to their investigations into the nature of static electricity generation, they have conducted a programme of research into the electrical properties of fuels. The initial outcome of this work appears to have solved the problem of static electricity, not only during refuelling, but during the various refinery processes as well. By investigating the possibility of dissolving other liquids into the fuel to increase its electrical conductivity, they have discovered an additive which will greatly reduce the charging capacity of the fuel. The additive consists of a mixture of calcium and chromium salts which, when added to the fuel in very small proportions (about $2 : 10^6$) increases the conductivity by a large enough factor to eliminate the possibility of a substantial electric charge being carried by the fuel. The possibility of undesirable side effects from this additive are now under investigation at Thornton.

It would not be unduly optimistic to expect that this technique will prove to be the final answer to a problem which has long been a source of concern to refinery engineers and which, in time, may have caused even greater concern in the field of civil aviation.

Hydrant Fuelling System

The advantage of the hydrant method of fuelling is that large quantities of fuel can be delivered to a number of aircraft simultaneously with a minimum of congestion of equipment on the apron. The fuelling plant consists of a pair of hydrant pits for each grade of fuel, located at the aircraft parking position and fed by pipelines from the airfield fuel depot. A small dispensing trolley containing microfilter, pressure control valve and fuel meter is connected to the hydrant pit and delivers the fuel to the aircraft by hose.

Hydrant fuelling has been in limited use for a number of years, but continuous development is necessary in order to meet the increasing demands for high flow rates and quantities. For this reason it is necessary to conduct research on the specialised components used, e.g., automatic pump control, hydrant pit valves, shock alleviators and dispensers.

One of the problems under special investigation is the occurence of hydraulic shock in a pumping system when valve closure occurs. This problem is one which arises during the fuelling of aircraft when either the aircraft tank or the fuel equipment tank is closed. The primary aim is to isolate the aircraft system from any shocks that occur and the secondary aim is to protect the ground equipment. The extent of the hydraulic shock that occurs in a function of the valve closure rate, the elasticity of the fluid in the system and the rate of flow before valve closure. Here again the problem is more acute at high flow rates.

Two methods are possible for reducing the severity of hydraulic shock. One is the use of special valve control gear which isolates the aircraft system from the high upstream surges; and the other is the use of pneumatic devices which, by increasing the elasticity of the fluid in the system, reduce the magnitude of the shock created. Much of the Thornton work has been concerned with the evaluation and development of these methods for overcoming the shock problem.

For dealing with this and other related problems, a simulated hydrant system is used, involving a considerable length of pipeline with the relevant pumping and handling equipment. In the case of the hydraulic shock work, the extent of the shock pressure is picked up in relevant parts of the system by means of pressure transducers which feed electrical pulses to automatic recording equipment. The recording equipment produces a complete record of the transient phenomena in the system, i.e., the changing shock pressures and the variation in the fuel flow rate.

MEETINGS AND PAPERS

Chemical Society

COVENTRY
"Polyethers," by Professor G. Gee. Birmingham Branch. At offices of Courtaulds Ltd., Coventry. Fri., 29 May, 7 p.m.

EXETER
"The Acetylenic Approach to the Synthesis of Natural Products," by Professor R. A. Raphael. Exeter Branch. Washington Singer Laboratories, Prince of Wales Road, Exeter. Fri., 22 May, 5 p.m.

Helicopter Association

LONDON
"Some Design Aspects of Tandem Rotor Helicopters," by J. D. Sibley and C. H. Jones. Royal Aeronautical Society, 4 Hamilton Place, Piccadilly, W1. Fri., 5 June, 6 p.m.

Institution of Civil Engineers

LONDON
"The Cape Town Wemmershoek Water Scheme," by S. S. Morris. Tues., 26 May, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
"The World Bank: What it is and What it Does," by P. J. Squire. Supply Section. Wed., 20 May, 5.30 p.m.*

EDINBURGH
Annual General Meeting. Scottish Centre. Carlton Hotel, North Bridge, Edinburgh. Wed., 27 May, 7 p.m.

Institution of Engineering Designers

BRADFORD
Annual General Meeting. Yorkshire Branch. Midland Hotel, Bradford. Wed., 20 May, 7.30 p.m.

Institution of Mining and Metallurgy

LONDON
Annual General Meeting (for corporate and noncorporate members only) at 4 p.m. Tea at 4.30 p.m. Presidential Address on "Some Observations on Gold Refining and the Standard for Gold and Silver Coinage," by Dr. J. H. Watson, at 5.15 p.m. Geological Society, Burlington House, Piccadilly, W1. Thurs., 21 May.

Institution of Structural Engineers

LONDON
Annual General Meeting. Thurs., 28 May, 6 p.m.*

Physical Society

LONDON
Annual General Meeting. Presidential Address on "Recent Trends in the Theory of the Ionosphere," by J. A. Ratcliffe. Royal Institution, Albemarle Street, W1. Thurs., 21 May, 5.30 p.m.

Royal Institution

LONDON
"The Molecular Basis of Life," by Dr. M. F. Perutz. Wed., 20 May, 9 p.m.

Royal Society

LONDON
"Kinetics of the Base-Catalysed Bromination of Ethyl Nitroacetate," by R. P. Bell and T. Spencer; and "The Point of Oxygen Attack in the Combustion of Hydrocarbons. II—The Formation and Origin of Ketons," by C. F. Cullis, F. R. F. Hardy and D. W. Turner. Thurs., 28 May, 4.30 p.m.*

Royal Society of Arts

LONDON
"Trade and the Bamboo Curtain," by the Earl of Verulam. Wed., 20 May, 2.30 p.m.

Society of Instrument Technology

NEWCASTLE UPON TYNE
Annual General Meeting. Newcastle Section. Stephenson Buildings, King's College, Newcastle upon Tyne. Wed., 20 May, 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this feature should reach the Editor not later than three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675.)
Helicopter Association of Great Britain, 4 The Sanctuary, London, SW1. (ABBey 5160.)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847.)
Institution of Mining and Metallurgy, 44 Portland Place, London, W1. (LANgham 3802.)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128.)
Physical Society, 1 Lowther Gardens, South Kensington, London, SW7. (KENsington 0048.)
Royal Institution, 21 Albemarle Street, London, W1. (HYDe Park 0669.)
Royal Society, Burlington House, Piccadilly, London, W1. (REGent 3335.)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366.)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251.)

On the Shelf

By Frank H. Smith

You know all those Latin tags and abstruse terms they use in the law reports in *The Times*? Well, they need fox you no longer. For eight guineas (it has to be guineas, being legal) you can get *The Dictionary of English Law*, by the late Earl Jowitt (Sweet and Maxwell the publishers) Did you know that a fund in medio was property upon which conflicting claims are made in an action of multiplepoinding? And multiplepoinding is very rude, as you should have been told—even *one* finger is naughty. The same publishers produce a useful list—for free—of books on those subjects of most interest to solicitors.

Collet's Holdings Limited (44 Museum Street, London, WC1) have long had a reputation for providing Russian material and they now have a new catalogue—" Collet's Russian Catalogue of Scientific Books 1959."

From Cambridge University Press (Bentley House, 200 Euston Road, London, NW1) comes a pleasant folder containing a selected list of books on the history of science. One quaint title is the *Bibliography of Sponges, 1551-1913*. The bloke who borrowed 10*s* from me in 1930 will not be included. But I still remember his name.

In the present state of thesis inaccessibility the annual *Abstracts of Dissertations* from Cambridge University (CUP) formed a very useful guide to what was going on at that University. Now the annual's value has been considerably lessened by its metamorphosis to *Titles of Dissertations* (1957-58). No reason is given but a copy of the summary may be obtained on application to the secretary of the Board of Research Studies, The Old Schools, Cambridge. The dissertation itself may be consulted by the " permitted " in the library and, with the author's permission, a microfilm is obtainable from the librarian—at the applicant's expense of course. So now you know what to do if you want Mr. Palmer's " The nature of the Vacuolation and the distribution of affected neurones in sheep suffering from scrapie." Says ewe. For myself, I prefer " Studies of degradation in the peptide field." I remember so well what happened to me in a field of peptide once.

In a burst of devilment the Institute of Scientific Information has decided to change its name—as from 1 April—to the Institute of Scientific and Technical Information of China.

Subtitled " A quarterly journal for power users " the Vulcan Boiler and General Insurance Company's *Vulcan* celebrates, with the April number, a hundred years history of the firm (67 King Street, Manchester 2). Six articles review the progress in that time of various fields of engineering in which vulcanists are interested.

Those interested in metal finishing processes may like to know of *Roto-Finish Record*, No. 2 of which I have recently had from Roto-Finish Limited, Mark Road, Hemel Hempstead, Herts. It is only a meaty four pages and will not take up much room in the book collection.

Have you ever watched a large pile of cotton wool in a mouse's cage? Suddenly it starts to heave and tumble like some miniature volcano and, after a while, a little pink snout appears and the mouse, awake at last, comes out and blinks. So it is with the stifling cotton-wool-pile of technical literature. Two little pink snouts have appeared. At a recent meeting of the Library Association one of the delegates is reported as asking if there are not too many scientific books published and, in the April *Mechanical Engineering*, the editorial is headed " Too many Meetings?" The latter ends " So the questions of whether too many meetings are being held and whether too many similar papers are being presented are still just questions. Comments, anyone?" My comment is that they are *not* still just questions. They are ndisputable facts.

EVERLASTING LUCKY DIP

Continuing the pattern set on 6 March (p. 310) I dip my hand into the bibliographic bran-tub and, shaking the sawdust from a package, I find the first of the *vade-meca—The British Journal Photographic Almanac* (*and Photographers' Daily Companion*) for 1959, edited by A. J. Dalladay. I like that quaint little bit about the " daily companion." I suppose it is a relic of a gracious past, since this is the 100th year of publication. Humble congratulations from one who does not know f3·5 from a double exposure. The almanac has five articles; a selection of abstracts; some wonderful photographs; a large section reviewing new goods and some of the black magic such as formulae, plan copying, narrow gauge cinematography (for miniature railways?) and oodles of tables. For another florin you can have cloth binding instead of boards.

Of course it's very nice to have a whacking great reference book that seems to have all the answers but they *do* take up such a lot of shelf room. On the other hand, you can consign quite a number of smaller textbooks to the store room if the fat one is adequate. Three inches thick from cover to cover is the *Electronic Engineer's Reference Book*, edited by L. E. C. Hughes for Heywood and Company at 4 guineas. This is the second edition in two years and the preface implies that there is not a great deal of alteration. There *is* an implication of a third edition to keep up with the rocketry and satellitery and, what is more, official bodies and journals and the dictionary of abbreviations have been removed to " another publication, which is directed to the commercial aspects of electronics." Just on 1,600 pages, 19 of them index.

And if that is not fat enough, what about our old friend " Kempe's " which once again comes in two volumes with a width of four and a quarter inches between them. It still comes from 28 Essex Street, London, WC2, and is in its 64th edition. 3,000 pages as near as dammit and enough engineering reading to last you a lifetime for 82*s* 6*d*. I shudder to think of the number of times Kempe's saved my life when I was a (very) raw library assistant at the Civils. There's not much you will not find in its index.

The Association of Supervising Electrical Engineers have five shillingsworth of *Year Book and Technical Guide*. This is not the type of year book which contains a list of members (so it's no good circular distributors getting a copy) but contains information of peculiar interest to " management and staff in the electrical and allied industries," which is, apparently, what the ASEE represents. Quite by chance I opened a page which was headed up " Seeing in or for " in one column and " 1m/ft² or f.c." in the next. It made sense when I turned back to the title " Schedule of recommended values of illumination on objects of special regard in various interiors or occupations." I like the special regard bit.

It takes a bit of believing but the *Mechanical World Year Book* is still only 4*s* 6*d*. I wonder what it was 72 years ago? According to the publicity material, the feature of the new edition is a new article on " cold-formed design," but bless my soul, you pay almost as much for a diary and here you've got ten times the information; and indexed to boot.

This bran-tub's full of glittering prizes. After the amazement of the last book for 4*s* 6*d* what do we have but the *Electrical Year Book* for 3*s* 6*d*! Same publishers, same pattern, but in this the bargain offer is a new section on transistors and a new section on magnetic amplifiers. Incidentally, in terms of pages, these last two books almost deadheat at 360.

Back now to the fat boys—*Electrical Trades Directory* 1959: *The Electrical Journal Blue Book* in its 77th edition. Benn Brothers of 154 Fleet Street, London, EC4, will supply your bookseller for three guineas plus three shillings for the stamp. Six short of 1,650 pages and they say it " still retains its supreme position of being the only complete directory of the electrical and allied industries . . ." Good stuff that. I retain my supreme position of being the only writer of On The Shelf for this journal (until the Editor reads this).

Machinery's Annual Buyers' Guide is edited by K. A. Hill. As you might have guessed, The Machinery Publishing Company Limited (21 West Street, Brighton, 1, and 83-117 Euston Road, London, NW1) publish it at 12*s* 6*d* (nothing for the stamp) and it is in its 30th edition. This is what it says it is (and there do not seem to be many trades that are not included) and there are also a *glossaire français-anglais*, a *glosario español-ingles*, a *technisches Wortverzeichnis* and a chunk of Russian which I'll bet means much the same if it weren't all Greek. 1,036 pages between limp covers of a hue usually associated with life-rafts. Another well-known *Buyers' Guide*, this time from *The Engineer*, is priced at 7*s* 6*d* plus 1*s* 9*d* postage. This, again, takes me back to my callow youth with awkward questions about who makes what, what manufacturer uses a certain trade name, what's the address of such and such a body. Another of those little handbooks which, the more they are used the more useful they become.

The Aeroplane Directory of British Aviation, 1959 has been the " bible " of British aeronautics for many years. The nine thumb-indexes cover service and civil aviation, technical and commercial aspects, the press, training and, most used of all, a " who's who ". The sponsoring

The British Journal Photograph Almanac 1959. Edited by ARTHUR J. DALLADAY. *Henry Greenwood and Company Limited, 24 Wellington Street, London. WC2.* (8*s*)

Electronic Engineer's Reference Book. Edited by L. E. C. HUGHES. 2nd Edition. *Heywood and Company Limited, Ingersoll House, 9 Kingsway, London, WC2.* (84*s*)

Kempe's Engineers' Year-Book, Vols. I and II, 1959. Edited by C. E. PROCKTER and B. W. PENDRED. *Morgan Brothers (Publishers) Limited, 28 Essex Street, London, WC2.* (82*s* 6*d*)

Year Book and Technical Guide 1958-1959. *Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1.* (5*s*)

Mechanical World Year Book 1959. *Emmott and Company Limited, 31 King Street West, Manchester 3.* (4*s* 6*d*)

Mechanical World Electrical Year Book 1959. *Emmott and Company Limited, 31 King Street West, Manchester 3.* (3*s* 6*d*)

Electrical Trades Directory 1959 and Electrical Journal Blue Book. *Benn Brothers Limited, Bouverie House, 154 Fleet Street, London, EC4.*

Machinery's Annual Buyers' Guide 1959. Edited by K. A. HILL. *The Machinery Publishing Company Limited, National House, 21 West Street, Brighton, 1.* (12*s* 6*d*)

The Engineer Buyers Guide, 1959. *28 Essex Street, London, WC2.* (7*s* 6*d*)

The Aeroplane Directory of British Aviation, 1959. *Temple Press Limited, Bowling Green Lane, London, EC1.* (30*s*)

Watch and Clock Yearbook 1959. *NAG Press Limited, 226 Latymer Court, Hammersmith, London, W6.* (2*s members of the British Horological Institute,* 3*s* 6*d non-members.*)

Heads and Threads: Buyers' Guide 1959. Published for the *British Bolt, Nut, Screw and Rivet Federation* by *Peat, Marwick, Mitchell and Company, Queens Square, Middlesbrough, Yorks.*

Produktenboek 1958. *Vereniging Van Metaal-Industrieën, Nassaulaan 13, 'S-Gravenhage, Holland.* (*Free of charge.*)

Répertoire National Du Commerce Extérieur 1959. *Union Française D'Annuaires Professionnels, 166 Boulevard Saint-Germain, Paris* (6*e*).

Norwegian Export Directory 1958-59. Nineteeth Edition. *Export Council of Norway, H. Heyerdahlsgt. 1, Oslo.* (50*s*)

British Plastics Yearbook 1959. *Iliffe and Sons Limited, Dorset House, Stamford Street, London, SE1.* (42*s*)

Tait's Electrical Directory of Australia and New Zealand, 1958-1959. *Tait Publishing Company Pty. Limited, 349 Collins Street, Melbourne C1, Australia.* (£A3)

Metal Industry Handbook and Directory 1959. *Iliffe and Sons Limited, Dorset House, Stamford Street, London, SE1.* (21*s*)

British Instruments Directory and Buyers' Guide. *Scientific Instrument Manufacturers Association and United Science Press Limited, Boswell House, 9 Gough Square, Fleet Street, London, EC4.* (42*s*)

journal has lately added "Astronautics" to its title and it remains to be seen what effect this will have next year on the content of what will then presumably be called "The Aeroplane and Astronautics Directory of British Levitation, 1960."

Here's something I've not come across before—and that's my loss. *Watch and Clock Yearbook* at 3*s* 6*d* or 2*s* if you belong to the British Horological Institute. I assume it is published by NAG Press Limited of 226 Latymer Court, London, W6, since their "comps slip" is inside, but the editor is certainly E. M. Bruton. Unlike many yearbooks, this one is of interest outside its own coterie (what *is* a bunch of esoteric people?) with such delightful articles as "How to Steal a Watch," "Repairing Musical Boxes," "Birthstones," and lots more like that. There is, of course, the usual yearbook stuff as well, which brings one to the thought—what should go into a yearbook? Any scope for a British Standard (who produce their own yearbook, anyway)?

The Accles and Pollock advertisements must be catching since the British Screw and Rivet Federation (joint secretaries, Heathcote and Coleman, 69 Harborne Road, Edgbaston, Birmingham, 15—Peat Marwick, Mitchell and Company, Queens Square, Middlesbrough) call their yearbook *Heads and Threads Buyers' Guide*. It sounds like a game with a companion "Nails and Tails." No price is indicated but the contents are such things as constituent associations, directory of members' products, index to BSS and a comparatively thumping great advertisement section (pages 34 to 96 out of 96 pages).

Now we try a bit of Dutch with no schnapps to help us out. *Produktenboek 1958*—conveniently translated to "Metal Products from Holland," and even more conveniently has the body of the book in most readable languages. The index conforms, with pink pages for English and different hues for other tongues. It's nice to think we have a pink tongue. The Spanish is green. Anyway—it is FREE from Association of Metalworking Industries, 13 Nassaulaan, The Hague. There are only 10,000 copies so get cracking.

The next volume has me slightly breathless. Not only is it 2 in thick but its height is over a foot and its width 9¼ in. *Répertoire National du Commerce Extérieur* has one of those systems where you put in a thumb, turn over the bulk of the pages and there you are—if you know where to put your thumb when you start. I drew a bow at a venture and found myself at industries agricoles, alimentaires et vinicoles. This was delightful because I see it deals with various food products and drinks. But, seriously, this volume appears to give the most amazingly comprehensive index to French industry. Like the previous work I mentioned, this has four languages (and once again ours is pink) in each section. The English index alone is 16 pages (of the size I mentioned) of some of the closest print I've seen. I have no idea of the price—if any—but no doubt 166 Boulevard Saint-Germain, Paris 6e, will tell you all about it. If you are in a tearing hurry, dial 100 and ask for Danton 82-86.

Another of the "stick-in-your-thumb" indexed directories is the *Norwegian Export Directory* at £2 10*s* from Norges Eksportråd. The nineteenth edition, it is in all sorts of languages, thus showing a Norwegian desire to trade with all and sundry. English seems to be the first choice, which is, of course, very gratifying. I feel we should return the compliment and trade with Norway for all we're worth. Would *you* know where to buy polar bear skins, elk skins, whaling ammunition? An unusual feature is a list of Norwegian embassies, legations and consulates throughout the world and this is indexed, alphabetically, by place-name at the end of the 377 page text. The advertisement pages, by the way, are in alphabetical order but the publishers have still gone to the trouble of providing an alphabetical index.

Twenty-ninth year of publication and it seems only yesterday that plastics first swam into our ken. Iliffe publish the *British Plastics Year Book* at 42*s*. This has the jut-out thumb index (and one assumes that the bits sticking out are plastics?) covering ten sections; 644 pages are required to cover this 20th century industry and one of the most fascinating sections is that devoted to "Manufactured Products." A casual glance down the list finds such items as beehives, braces, cocktail sticks, doors, hair curlers, lollipop moulds, overshoes, pipes (tobacco) (Ugh!), teeth (artificial) (more ugh!), venetian blinds and our old friend zip fasteners. I always have a job to tear myself away from Woolworth's plastic counter and if I go on looking at this book I'll not get finished tonight.

Now for a trip "down under" with *Tait's Electrical Directory of Australia and New Zealand*. The 13th edition, it costs £A3, which is like ours only it's kept in a pouch instead of a purse. There *is* a place called Wagga Wagga and it pays 9*d* a unit for the first 18 a month, 3*d* for the next 82 and the balance at 2*d*. All this sort of information and much besides is in here and you get it from Tait Publishing Co. Pty. Ltd., 349 Collins Street, Melbourne C1.

We are now getting near the bottom of the tub and I am bringing up more sawdust than prizes. However, here is a limp covered *Metal Industry Handbook and Directory 1959*, again by Iliffe at a guinea. One can almost see the plastics compilers and the metal compilers avoiding each other in the corridors of Dorset House. The composition of this is quite different from the first mentioned. More than half the book is handbook (white pages) which is a section on "General Properties of Metals and Alloys," and pages 437 to 564 (the end) are green, and the directory.

Scrabble, scrabble and I nearly overbalance as, last to come out, I wave *British Instruments Directory and Buyers' Guide*—"a complete and up-to-date compendium, guide and handbook to sources of supply of all British scientific and industrial instruments and their component parts," 320 pages full of all sorts of lists by manufacturer, goods produced, "classified" and the rest of the requirements of a trade directory. This does not quite come up to the quadrilinguisticality (my own) of the Continental handbooks, but glossaries are provided (section 6) in French, German and Spanish. The cost is two guineas and the publishers are United Science Press Limited, 9 Gough Square, London, EC4.

Well! There you are. That's the lot and if you don't know the answers now—you never will. Does anybody want a barrelful of sawdust?

F. H. SMITH

Mr. Frank H. Smith, in spite of everything, is still responsible for On the Shelf, though responsible is perhaps a curious word. His experience includes service with the Merchant Navy and the Institution of Civil Engineers, and he describes himself as "that well known bon-viveur, entrepeneur, maladriot, chercheur de femmes and general je ne sais quois who is malgré lui bibliothecaire de la Société Aéronautique Royale."

NEW BOOKS

Atomic Terminology. Compiled by LORE LETTENMEYER. *Temple Press Limited, Bowling Green Lane, London, EC1.* (42*s*)

A dictionary of nuclear science in English, German, French and Italian. The English word is given first and the other languages are indexed and cross-referred by number.

Calcul de l'Écoulement en Conduites Sous Pression ou a Surface Libre. By P. A. ARGHYROPOULOS. *Dunod, 92 Rue Bonaparte 6e, Paris.* (*3,800 F*)

"Dette étude . . . réunit de nombreux tableaux, graphiques et abaques qui fournissent la solution cherchée pour chaque problème sous une forme simple, pratique et précise."

Glossary of Terms Used in Vacuum Technology. Published for *Committee on Standards of American Vacuum Society Incorporated by Pergamon Press Incorporated, 4 and 5 Fitzroy Square, London, W1.* (10*s*)

"Tight—Free from leaks according to a given specification" seems a fair enough definition though not everybody would allow *any* latitude. Most of the other definitions have a narrower field and the glossary will be useful where they differ from English practice.

Modern Fishing Gear of the World. Edited by HILMAR KRISTJONSSON. *Fishing News (Books) Limited, Ludgate House, 110 Fleet Street, London, EC4.* (105*s*)

The fish does not stand a chance but this brings trawling and the catching of fish for food to a fine art. One must hope that there is no scheme for piscatorial family planning. Not a book for trawler skippers.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Bearing Manufacture. BRITISH TIMKEN LTD., Duston, Northampton. "Visiting British Timken" is the title of a brochure describing in pictures and words the products of the firm.

Chlorinated Rubber. EXPANDIT LTD., Chase Road, London, NW10. "Expaflex" protective coatings for metal, concrete or brickwork; resistant to acids and alkalis. Available in a range of colours. Leaflets.

Bituminous Paint. WAREING BROTHERS & CO. LTD., Carlton Street Works, Bolton, Lancashire. "Blackpete" brush bituminous paint for metal or concrete surfaces. Folder.

Electronics

Travelling Wave Systems. MARCONI'S WIRELESS TELEGRAPH CO., LTD., Marconi House, Chelmsford. All travelling wave tube systems, their features and advantages, as exampled by the HM 500 link equipment. Brochure.

Relays. LONDEX LTD., Anerley Works, Anerley Road, London, SE20. Relays, delays, timers, pressure switches, and the like. 44 page catalogue.

Potentiometers. ELECTROFLO METERS LTD., Abbey Road, Park Royal, London, NW10. High speed continuous balance electronic potentiometers for low potential signals. Available as recorder or recorder controller. Publication 197.

Silicon Rectifiers. TEXAS INSTRUMENTS LTD., Dallas Road, Bedford. Application report on d.c. power circuits using silicon rectifiers, single phase and three phase. With worked examples, bibliography and design curves. Booklet.

Data Processing. FERRANTI LTD., Hollinwood, Lancs. The Perseus computer; main features and examples of operation. Booklet DC 35.

Valves. FERRANTI LTD., Gem Mill, Chadderton, Oldham, Lancs. Revised pages for the technical handbook on valves and CRT'S; 22 new sheets.

Relay Calculator. KEYSWITCH CO., 2 Irongate Wharf Road, Praed Street, London, W2. Selection chart for relays, types BPO 3000 and BPO 600.

Counters. THE STONEBRIDGE ELECTRICAL CO., LTD., Queens Gate, London, SW1. Impulse counters, manual or electrical reset, single or multi digit types, Leaflet.

Timer. ELECTRICAL REMOTE CONTROL CO. LTD., The Fairway, Bush Fair, Harlow, Essex. Miniature timer type AMS automatic multiple circuit, multiple interval, synchronous unit. Ten standard ranges. Size 2⅞ in by 3½ in by 6½ in. Leaflet.

Remote Control. DEWHURST AND PARTNER LTD., Inverness Works, Hounslow, Middlesex. Equipment and components for the Dupar remote control push button system. Leaflet.

Components. KELVIN AND HUGHES LTD., New North Road, Barkingside, Essex. Amendment No. 2 to components catalogue. Servo motors, recording head, potentiometers, etc. Leaflets.

Servo Components. SERVOMEX CONTROLS LTD., Crowborough, Sussex. Range of Feedback components for the experimental assembly of precision servo systems; base plates, clamps, gears, etc. Folder.

LOW TEMPERATURE STRESS RELIEVING OF WELDED PLATEWORK

By J. C. Dixon, B.Sc.

The welding of platework such as in storage tanks, receivers and welded ships introduces a considerable amount of residual stress in the areas adjacent to the weld and this stress can, under certain conditions, cause failure of the material. The standard means of relieving these stresses are heat treatment or peening. Stress relieving by heat treatment is very effective but usually necessitates the use of a furnace, which is not always possible, while stress relieving by peening is not usually considered to be reliable.

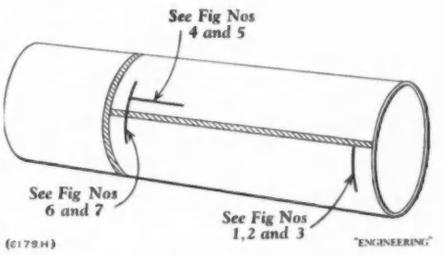
The Linde method of low temperature stress relieving can be used on any section of welded platework however large, and at the same time is effective in removing a greater part of the residual stresses. In addition, the process is comparatively inexpensive and capable of being automatically controlled. This method originated in the United States, was developed by the Linde Air Products Company, and the Sun Shipbuilding and Dry Dock Company, and has been applied to a number of welded ships with, it is claimed, successful results. The licence for the process in Gt. Britain and the Commonwealth is held by British Oxygen Company Limited and equipment made up by this Company was used by Imperial Chemical Industries Limited to stress relieve pressure vessels. The process had not been employed on any large scale however, until the Redheugh Iron and Steel Company (1936) Limited, decided upon this method to stress relieve some welded steel piles for which no furnace was available because of their length (80 ft).

PLASTIC DEFORMATION BY HEAT

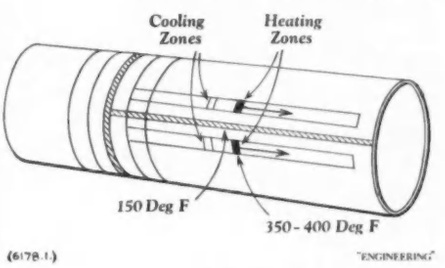
During the process of welding, constraint by the adjacent plates causes residual tensile stresses in the weld metal which can be locally severe. In the Linde process of stress-relief, heat is applied to the plate on either side of the weld so that the weld metal is at a lower temperature than the surrounding hot areas. Although elastically constrained by the even larger unheated plate, the slight expansion of the hot areas may be sufficient to superimpose further tensile stress on the weld metal. This, in addition to the residual stresses, may cause plastic flow in the highly stressed areas, which on redistribution of strain after cooling may yield a less severe stress pattern.

With steel the temperature rise required to produce elongation equivalent to strain at a yield point of 15 ton per sq. in, is about 180° F, so that stress relief may be effected by quite low temperature differentials.

The process is by no means perfect in the sense that it will entirely remove all residual stresses. However, properly applied, it will reduce residual stresses to a point where they are no longer a potential source of failure.



Positions where stress measurements were made. (The figure numbers relate to the diagrams opposite).



Positions of heating and cooling zones in stress relief.

In practice, heating the surrounding areas to between 350 and 400° F and cooling behind the burners were found—by analysis of the stresses before and after treatment—to have provided temperature differentials which removed the areas of high tensile stress.

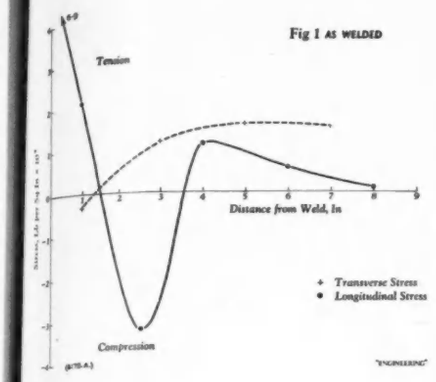
The heating was accomplished by running oxy-acetylene blowpipes parallel to and on either side of the weld, and the cooling by water sprays on the plate behind the advancing burners. The temperature attained by the heated metal is dependant upon both the " power " of the blowpipes and their speed of travel and, in practice, is varied by means of the latter.

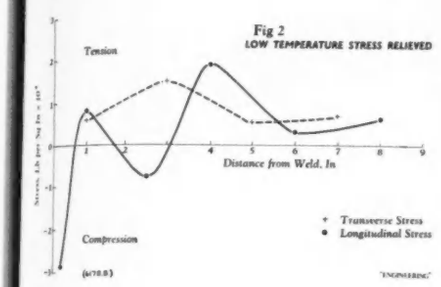
The relative positions of weld, blowpipes and water sprays is of importance in attaining the correct temperature differences but this would appear to be beyond the scope of calculation and best found by practical experience. Good results have been attained with 6 in wide blowpipes having their inner ends 2 in on either side of the weld with water sprays 6 in behind the blowpipes, but this is a matter for further research.

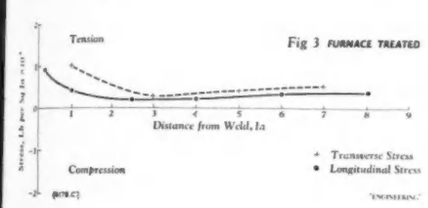
Each set of equipment consisted of 2—6 in heads of the type normally used for flame cleaning with provision for raising and lowering the heads, and 2—6 in water quenches positioned behind the heads. The equipment for the longitudinal welds was mounted on a motor driven tractor with variable speed range, and that for the circumferential welds on a trolley. Control valves for oxygen, dissolved acetylene and water were mounted near the blowpipes to facilitate operational control.

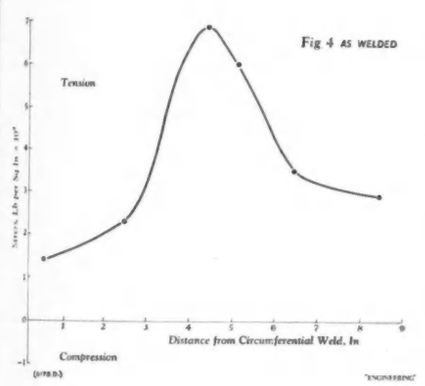
TEMPERATURE MEASUREMENT AND CONTROL

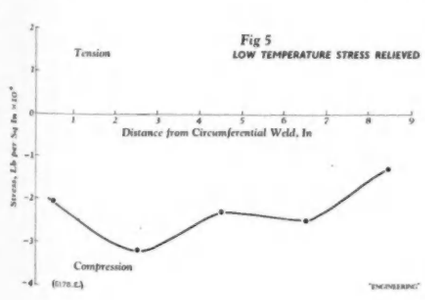
An attempt was made to measure the temperature of the heated portion by means of a thermocouple with a flexible strip rubbing on the

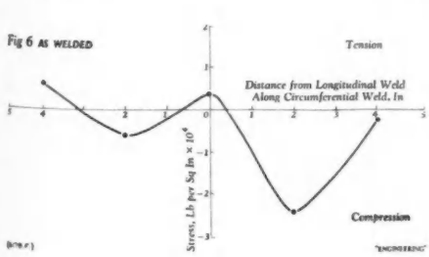


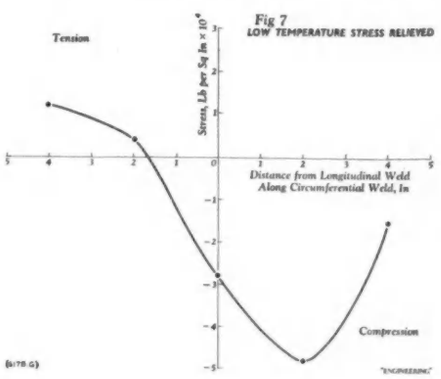












metal immediately behind the blowpipes, but difficulties were encountered in effectively shielding it from direct radiation. Recourse was finally made to a seemingly rather primitive but nevertheless effective method using Tempilstiks, a proprietory article shaped like a crayon and formed from a fusible clay which is so alloyed as to melt at a definite temperature. The illustration shows a temperature check being made during treatment of a longitudinal weld.

The method could be made automatic, with the speed of burner travel adjusting itself so as to maintain the desired temperature. In addition this temperature could be graphically recorded.

A temperature check being made during treatment of a longitudinal weld.

EVALUATION OF PROCESS

The only satisfactory method of testing the effectiveness of the stress-relief was to measure the actual residual stress at various points in the material, comparing these stresses with those present in both "as welded" and fully treated specimens. A series of tests with strain gauges were carried out by Messrs Clarke, Chapman and Company.

Strain gauges were attached to the already stressed material and resistance measured, after which the portion of metal to which the gauges had been cemented were cut out of the parent material. This operation relieved the residual strains and varied the resistance of the strain gauges, these variations being a measure of the residual stresses. In practice many difficulties arose in obtaining true results owing to extraneous factors such as change of atmospheric temperature.

The results as obtained are shown on the graphs reproduced on the previous page. They all indicate a reduction in residual tensile stress and, while the overall effect was not so good as that with a furnace treated specimen, the danger of failure due to residual stresses was practically eliminated. In several areas the tensile stresses had been replaced by less harmful compressive stresses.

CONCLUSION

It appears that the Linde low-temperature process of stress relieving is effective in reducing residual stresses and is a practical and economic one capable of further development. Further research and experiment should provide data to establish optimum conditions such as the correct temperatures, the size and position of blowpipes, and the relative position of water sprays, which should result in even greater effectiveness in reducing residual stresses.

FABRICATION OF HIGH TEMPERATURE MATERIALS

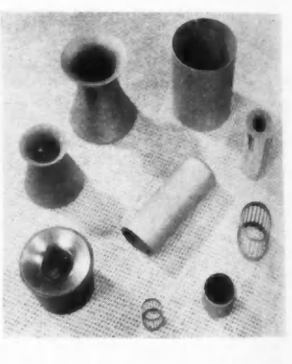
Refractory Metals and Ceramics Sprayed with Plasma Torch

If a material can be melted and sprayed, it can be applied as a coating, hence flame spraying or metallising; if this coating is self-adherent and moderately tough, it can be built up to a thick layer; and if this layer is formed on a mandrel or pattern, which is subsequently removed, the article can be called spray-formed.

Now a device patented by Linde in the United States allows powders or wire to be melted in a high power electric arc which attains temperatures up to 16,000° C; so using this plasma arc torch as it is called with the process of spray-forming, here is a method of fabricating parts from refractory metals and ceramics which are very difficult to make otherwise. Examples are metals such as tungsten melting at 3,410° C, molybdenum, niobium, tantalum and zirconium; the refractory oxides of aluminium melting at 2,020° C, of magnesium, thorium, cerium and zirconium; and the refractory carbides of niobium, hafnium, zirconium, titanium, tungsten and vanadium. Most of these could be fabricated otherwise; certainly all could be made by powder metallurgy techniques of compacting and sintering. Tungsten lends itself to slip-casting, and the less refractory metals with alumina are already being fabricated as coatings or in massive form by flame spraying with an oxy-acetylene flame. The plasma torch has increased the top temperature limit, however, and gives added advantages, among which is improved density.

Although a plasma device was first built in Europe 35 years ago, the modern plasma arc did not come until 1955 when Linde introduced the Heliarc plasma jet for cutting aluminium. The present plasma arc torch is the latest step, and engineering work is continuing with bigger arcs and higher concentrations of power. The basic principle of the plasma torch is quite simple, although many design problems have arisen during its development: the metal or substance to be worked is prepared in either wire or powder form and is passed through an intense arc which is struck inside the torch. Because of the high heat of the arc, material passing through it is converted into a fluid. The liquid material is carried out of the torch by inert gases flowing at speeds up to 10,000 m.p.h. and deposited on a form or a part being coated with such force that a firm bond results. Linde cool the sprayed layer with carbon dioxide and give the articles a high temperature heat treatment to increase density.

(*Left*) *Tungsten is sprayed on to a dispensable mandrel in the process of spray-forming.*



(*Right*) *Gases and molten particles emerge from the plasma torch at speeds up to 10,000 m.p.h., resulting in dense components or coatings.*

The choice of wire or powder—and there is a separate torch for each—is largely one of convenience or economics. Stainless steel, for instance, is readily available in wire form and would most often be used with the wire-fed plasma arc torch. Tungsten and the carbide materials, on the other hand, are more usually found in powder form and are regularly used with the powdered arc torch.

There are no known limitations on size or complexity of shape of articles which may be fabricated with this method. Where formed parts are not required, the plasma arc torch can be used to coat virtually any material, including reinforced plastics, with a variety of metallic or refractory platings. The limitation on choice of material which can be applied by this method is that it will melt in the high temperature of the plasma, before it dissociates or reacts with the surrounding atmosphere. In addition to experimental rocket and missile parts of pure tungsten or tungsten-coated graphite, the new torch has already been used to produce high density tungsten crucibles for metallurgical purposes, special parts for nuclear work, sensitive electrical contacts, and electronic components and X-ray targets of high density, and a selection of these articles in solid tungsten and tungsten coated graphite is shown in the illustration immediately above.

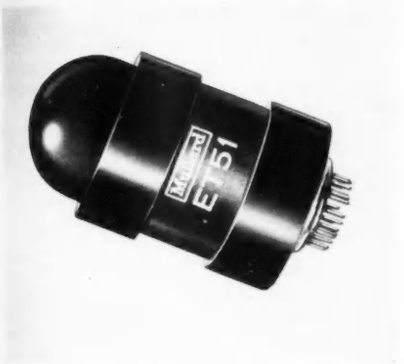
Several gases may be used with the plasma torch—nitrogen, hydrogen, helium and argon have been tried with success. The maximum temperature depends on the gas flow rate and the electrical power input.

The efficiencies of heat transfer to the gas have been quoted by the Thermal Dynamics Corporation, makers of a similar plasma torch, as being in the range of 40 to 80 per cent with power inputs of 10 to 70 kW. If the heat transfer to the powder or wire material is as efficient as with the oxy-acetylene spraying processes now used, there is no reason why this plasma process should be very expensive. It is true that at the present state of development, the oxy-acetylene process is easier to handle and the equipment is readily available, but these drawbacks of the plasma process are likely to disappear with development and increased use. Indeed, the methods of spraying with plasma or oxy-acetylene for the purpose of coating or spray-forming are complementary to one another, and both have opened new horizons for coating and fabricating in high temperature materials.

HIGH SPEED COUNTING TUBE

A trochotron high-speed decimal stepping tube, for use as a counter or selector at speeds up to 1 Mc/s, has been introduced by Mullards Limited of Torrington Place, London, WC1. Known as type ET51, its chief uses will be in nucleonic scalers, decimal computing equipment, and electronic switching circuits. In these and similar applications, one ET51 with its relatively simple circuitry can replace a number of conventional valves or transitors and their associated components. It is switched by a negative signal and provides a constant current output of 5·5 mA, which is sufficient to drive a cold cathode decimal indicator and is compatible with the input requirements of a direct read-out digital indicator.

The trochotron is a vacuum device which



makes use of crossed electric and magnetic fields to form a beam of electrons between a thermionic cathode and any of ten groups of three electrodes mounted radially about the cathode. The electric field is provided by the inter-electrode potentials within the tube and the magnetic field by a cylindrical permanent magnet which is fitted externally around the glass envelope.

Each group of electrodes consists of a spade, which forms and locks the beam in position; a target, which makes the beam available as a constant current output; and a grid, for switching the beam from one spade to the next. When power is first applied, all spades will be equally positive with respect to cathode and, due to the action of the magnetic field in preventing electrons reaching the electrode-groups, the tube will be in a "cut-off" condition, with no beam formed. However, if the potential of any spade is reduced, by means of a high-speed pulse or a d.c. voltage, the beam will form on the electrode group associated with that spade, and an output will appear on the corresponding target.

Once formed, the beam is held in this position by a combination of the spade series resistance and spade current until it is stepped to the next position by lowering the voltage on the associated switching grid.

Since only the grid in its immediate vicinity will affect the beam, the grids are connected internally in two groups: the odd-numbered grids in one, the even-numbered in the other. This makes it possible to use a d.c. input for switching and still obtain single-position stepping, thus avoiding the necessity for a pulse of critical width.

The output characteristic of the trochotron is similar to that of a pentode valve, and in the ET51 over 80 per cent of the beam current appears in the output, the remainder being used to form and lock the beam.

The ET51 is mounted on a special 26-pin (B26A) base comprising ten connections each for spades and targets, two grid connections, and heater and cathode connections. It has an overall seated height of 3·3 in (84 mm) and an overall diameter of 1·74 in (44·2 mm), including the magnet and special protective caps.

Typical operating conditions for the tube are: Spade: voltage 100 V, current 1·0 mA and load resistor 100 kilohms. Target: voltage 100 V and output current 5·5 mA. Grid voltage 25 V, input pulse − 60 V, cathode current 6·5 mA, and heater characteristics 6·3 V, 300 mA (a.c. or d.c.).

NOISE-ABSORBING PYRAMIDS

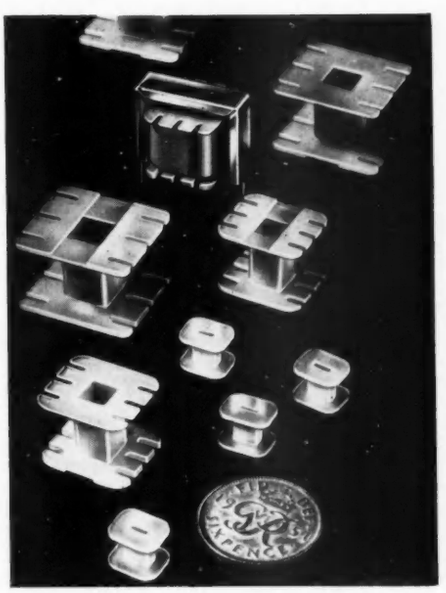
High noise intensity is a danger to many people and has a distressing wear-and-tear effect on everybody. An efficient approach to sound absorption is the use of acoustic pyramids of suitable material and the Marley Group, of Sevenoaks, Kent, are making a range of such units for which the sound absorption is greatest at the lower-middle frequencies and reduced at the higher frequencies. This characteristic is generally considered favourable for reducing the total reverberation without losing anything of the quality of speech or instrumental brightness.

The Marley acoustic pyramid is described as a "functional absorber," formed from rigid pvc, perforated, and filled with mineral wool. The base of each pyramid is 22 in square, including a ½ in flange; the depth, apex to base is 8½ in. At a frequency of 1,000 cyles per second the absorption reaches the high figure of 95 per cent. Over the wide range of 125 to 2,000 c/s, the absorption is claimed to be in excess of an average of 60 per cent. To fix the pyramid there is a helical spring fixed inside at the apex and this is hitched to a hook set in the wall or ceiling; the base is therefore easily aligned to walls and mating edges. The pyramids are made in a number of colours.

NYLON BOBBINS FOR SMALL TRANSFORMERS

Nylon coil bobbins for the miniature transformers used in conjunction with printed circuits and similar scale work have been introduced into the extensive range made by George Goodman Limited, Robin Hood Lane, Birmingham 28. The bobbins are designed with universal slots for bringing out leads and also have a hole flush with the inside of the former for the first tapping. Some examples are shown in the illustration below.

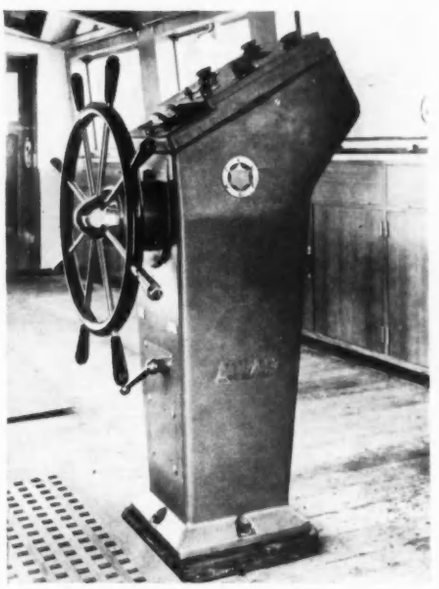
The bobbins are made by a high-speed single-impression technique which permits repeatable accuracy at a low cost. Being one-piece construction they are easy to handle during assembly work and the nylon from which they are made gives them a high dielectric strength.



COMBINED STEERING CONTROLS

Even in the largest ships space in the wheelhouse is a valuable commodity. The more coordination and grouping of essential instruments and controls that can be achieved, the more efficient the central control of the vessel can become. In the large vessel there can be wasted time and effort involved in moving from one control point to another, and in the small vessel there is the obvious problem of congestion.

One aspect of the way in which this problem is being tackled is by combining the different forms of steering control. In the interests of safety and reliability it is desirable to employ more than one steering control circuit, whether it be hydraulic or electric, from the wheelhouse to the steering engine aft. Moreover, many vessels have a gyro compass and automatic



steering is fitted. Until comparatively recently, however, automatic steering has been a separate major unit which has been installed alongside, and sometimes some distance away from, the primary control stand.

The logical combination of these two control positions began with equipment such as the Sperry electric and automatic steering control (in effect a Gyropilot with additional control circuits to provide duplication) introduced in the late 1940's and fitted in a substantial number of ships, especially tankers. This equipment involved either the elimination of the hydraulic telemotor control or, in those ships fitted with electric steering, the partial substitution of the Gyropilot system for the steering-engine manufacturer's system.

Within the last few years, however, the desirable features of combination and reduction in space requirements have been achieved which embody all the advantages of both types of system, hydraulic telemotor or all-electric control and automatic. Thus, for example, there is now a new generation of "gyro-hydraulic" and "gyro-electric" steering controls coming into service to provide all the necessary controls from a single combined unit mounted centrally in the wheelhouse, and adaptable to any particular type of steering engine equipment. By modifying standard Sperry components, combinations have already been designed for the Gyropilot system with 13 different types of steering gear made by the principal manufacturers in the United Kingdom and on the continent.

The illustration shows the Sperry-Atlas gyro-hydraulic steering control that is installed in the 31,000 ton turbine tanker Hadrian.

HYDROSTATIC DRIVES

Review of Dowty Practice

The hydrostatic drive has created interest as a tractor drive, but the potential field is very much wider than that single demonstration vehicle indicated. This article considers the technical advantages of hydrostatic transmission, and the immediate and future possibilities. It is based on an exclusive interview with Mr. E. H. Bowers, director and chief engineer of Dowty Hydraulic Units Limited, who has been intimately concerned with the development of the Dowty hydrostatic unit, and on inspection of the units both in operation and production.

RECENT demonstrations of a tractor fitted with the Dowty hydrostatic transmission have aroused considerable interest in this form of drive among the designers and users of a wide range of vehicle types. The demonstration tractor represents only the beginning. It would seem likely that the hydrokinetic or torque converter hydraulic drive, will be strongly challenged by the hydrostatic drive in many existing vehicles, why, with all the apparent advantages, the hydrostatic drive has not been so applied before lies chiefly in the difficulty of designing to a size, weight, and efficiency, which is acceptable in the vehicle and allied fields.

In an ordinary variable-displacement pump, with an average performance, the losses in a pump at maximum delivery and maximum pressure amount to about 10 per cent. If that

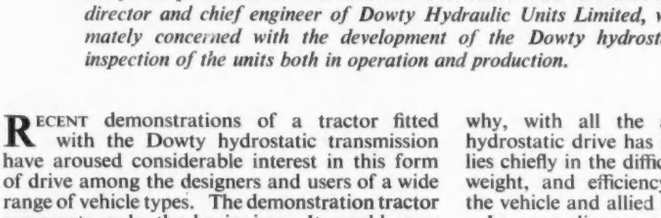


Fig. 1 Typical hydrostatic transmission circuit.

a, Pump. *b*, Servo jack and control valve. *c*, Speed-control lever. *d*, Booster pump. *e*, Filter. *f*, Non-return valve. *g*, Reservoir. *h*, Suction strainer. *j*, Cooler. *k*, Relief and shuttle-valve block. *l*, Motor.

and that there will be many applications to vehicles where the performance of hydrokinetic units is not acceptable.

A hydrostatic drive is, in general terms, a hydraulic drive using high pressures and relatively low velocities, the system comprising basically two-piston units and positive displacement of the oil. By comparison, the torque converter or hydrokinetic type of transmission uses the kinetic energy of a high-velocity flow of oil from a centrifugal pump, delivering the fluid to a turbine. The advantages which the drive can offer them is discussed in greater detail later.

To meet the requirements of this field, units capable of transmitting between 40 and 70 h.p. with torque speed ranges of 4 : 1 will be in production by the middle of the year, and vehicles such as crawler tractors, road rollers, narrow-gauge locomotives, handling equipment, and aircraft tugs with hydrostatic transmissions will become increasingly familiar. Both larger and smaller sizes are under development. These, together with a variety of arrangements of the same basic units possible, will probably provide an available range of horse-power from 20 h.p. to more than 600 h.p. during the next few years.

The drive, as is already quite well known, permits the use of a single simple lever, or single pedal control, for the infinitely variable selection of both forward and reverse speeds, and for braking. In rigid vehicles, such as crawler tractors, the drive can also provide steering control of a simplicity and accuracy not hitherto possible.

REDUCED UNIT SIZE

Hydrostatic drives, as such, are not new. They have been in use industrially and in ships for many years, and the circuit shown in Fig. 1 is not unorthodox. The present interest in this type of drive for vehicles is the result of development of units so reduced in size and weight that they can be installed in the limited space available while, at the same time, maintaining or improving upon the efficiency of the larger industrial hydraulic drives. The main reason pump is used in a transmission with a variable torque-speed ratio, however, the maximum flow and maximum pressure never coincide. The power transmitted by a given pump is only about one-quarter of its normal commercial rating. Thus, if the losses remain the same, they now form a proportion of the power being

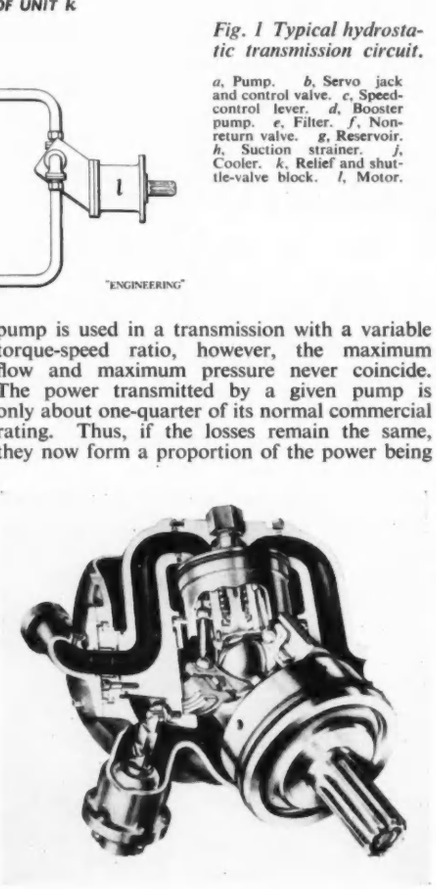


Fig. 2 Sectional arrangement of the pump (type 240).

transmitted four times larger, and 10 per cent losses become 40 per cent. If the power output is further reduced by losses of the same order in the motor, the efficiency of the transmission, even using units with an exceptional commercial efficiency, goes down to about 40 per cent. By comparison, the Dowty designers believe that, using hydrostatic transmissions with units specifically designed for the job, they can safely set themselves a target of maintaining an efficiency better than 80 per cent over the whole speed range.

A sectional view of the Dowty pump is given in Fig. 2. It has an axial plunger and tilting head and is capable of full flow in either direction. The motor is of the fixed-displacement type and uses rotating parts and a valve system identical with those of the pump.

The improved efficiency has been achieved by increasing the operating pressure to 4,000 lb per sq. in, increasing the rotating speeds to allow direct drive from a diesel engine, and the adoption of a design which gives a high displacement for a given envelope. At the same time, the design has been simplified for production purposes and ball or roller bearings are used to take all critical bearing loads. This eliminates the deterioration in performance due to excessive leakage which often occurs when wear or small scores upset the functioning of hydraulically balanced bearing surfaces normally used for rotor/valve plate bearings. In fact the pistons themselves and the rotary seals are the only details subject to high-speed rubbing contact.

The designers have carried out 30,000 hours of bench and vehicle testing to ensure that the pump and motors can reliably maintain their performance over a satisfactory life, and cope with the sudden temporary overloads to which a vehicle transmission is subject. A minimum life of 500 hr on continuous 25 per cent overload has been obtained, and deliberate abuse of test vehicles has shown that, with correct installation, the hydrostatic drive is actually more robust and resistant to misuse than the best mechanical drives.

TORQUE CONVERTER COMPARISON

If a straightforward hydrostatic drive employing a variable displacement pump and a fixed displacement motor is considered, as shown in Fig. 1, the basic performance differs considerably from that obtained from the torque converter or the torque-converter coupling. Since an infinite torque cannot be tolerated, all transmissions have a limiting torque ratio and, with the possible exception of a hydrostatic transmission using a variable displacement motor, a well-defined limiting speed ratio. In the case of the simple transmission in Fig. 1, the limiting output torque is determined by the maximum permissible pressure acting on the motor, and the limiting output speed is reached when the full pump displacement is used. Pressure limitations therefore impose a flat top on the power curve, as shown in Fig. 3. As this flat top normally represents the maximum torque that can be handled without wheel or track slip, it does not limit vehicle performance.

Torque ratios higher than those obtainable with hydrokinetic drives may be used with hydrostatic units, though the ratio should be kept to the minimum acceptable figure to obtain the best efficiency with the smallest units. This is so because the constant power that can be transmitted by a given pair of units is determined by the theoretical power-transmitting capacity divided by the torque ratio. The theoretical power-transmission capacity may be defined as the power that could be transmitted without a torque ratio if the maximum pressure and maximum flow coincided.

EFFICIENCY COMPARED

In comparison with the torque converter the hydrostatic drive shows a much flatter efficiency curve when plotted against speed ratio. Fig. 4 shows the input/output efficiency of three different transmission expressed as a percentage of the maximum input horse-power. It can be seen that the hydrostatic transmission has generally a higher efficiency and that the difference is most marked at the extremes of the range. A torque-converter coupler with or without lock-up can offer a higher efficiency at a 1 : 1 ratio, but this is obtained at the expense

of a lower efficiency under other conditions. These curves show the efficiency of the same three transmissions obtained if the output horse-power is taken as a percentage of the actual input horse-power and plotted against the torque multiplication ratio. The large difference is mainly due to the fact that both hydrokinetic units require almost full power input to provide maximum torque multiplication at near stall speeds, whereas the hydrostatic transmission requires less than 20 per cent of the full power input to provide the same torque multiplication.

From these figures it is apparent that the hydrostatic transmission can out-perform the torque converter without coupling or lock-up but cannot offer the same efficiency as the torque converter with lock-up when a 1 : 1 ratio is reached. This suggests that the advantages of a straightforward hydrostatic transmission are most marked in those types of vehicle which spend the majority of their lives in what would normally be termed as "indirect ratios." If the period spent in the indirect ratios is short, a lower efficiency in this condition is acceptable and the lower weight of the hydrokinetic unit is very much in its favour. Conversely, most vehicles which spend only short periods in a fixed top gear are of heavier construction and can benefit considerably from the extended efficient performance range of the hydrostatic transmission.

IMPROVED CONTROL

The other main difference between the two types of transmission concerns control characteristics. Without a tail-shaft governor, hydrokinetic units cannot hold a fixed speed ratio with varying output torque. By contrast, the hydrostatic transmission can be set to hold a given ratio independent of load conditions, though it is very simple to provide an automatic over-ride which automatically changes the ratio if the load conditions are such that the engine power is inadequate for the ratio selected. The precise ratio control in both forward and reverse directions and the braking effort obtainable by a reduction in ratio, offer manoeuvrability of a standard which has not been achieved by any other form of transmission. In the case of crawler tractors the use of a separate drive to each track powered by a single engine makes

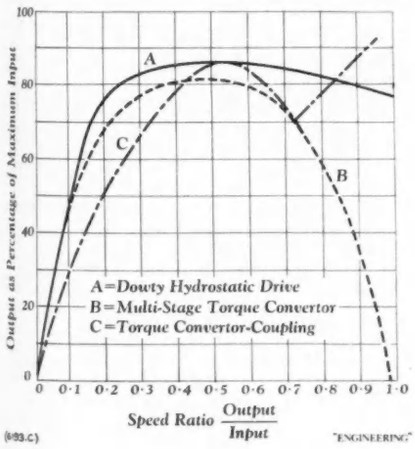


Fig. 3 Power transmitted at varying speeds.

full use of these control characteristics for both speed control and steering.

Summarising, hydrostatic and hydrokinetic drives are complementary rather than competitive. Each has advantages and disadvantages and the most suitable system varies according to the type of vehicle and performance required. In those vehicles where precise speed control, manoeuvrability, and efficiency in the torque multiplication range are of importance, it seems certain that the hydrostatic transmission will find increasing favour. Although in terms of size and weight the hydrostatic system appears to be at a disadvantage when compared with a mechanical gearbox and fluid coupling, this disparity is reduced or eliminated if a more comparable arrangement, such as a fluid coupling with "hot shift" change speed box with six forward and six reverse ratios is considered. Moreover, if the greater freedom of vehicle layout permitted by the absence of the mechanical drive line is taken into account, it seems likely that the improved performance can be obtained without increases of cost or weight.

TYPICAL APPLICATIONS

Road-Rolling Machines.—The main advantage is, first, the ability to select exactly the right speed for the job in hand, making use of the infinite variation possible; second, the smoothness of reversibility without clutches, enabling the roller to come to a standstill and start off again, without a dwell period which produces a depression in the road; and because it is possible to go direct from forward into reverse without disconnecting the drive. There is thus no danger of the roller running away on a hill in the interim period which must exist when clutches are used.

Narrow-Gauge Locomotives.—Many of the narrow gauge locomotives are used by very unskilled drivers, particularly overseas in applications such as on sugar plantations. The utmost simplicity of control is essential. This is not now being achieved by hydrokinetic transmissions because there are inevitably changes of gear during which even reversals of torque take place. Another point in favour of hydrostatic transmission is that excessive wheel spin is unlikely because a ratio can be set and held and, once the wheels start to slip, they do not race away as they can do with forms of transmission which have no definite ratio. Lastly, the ability of the hydrostatic transmission to work for very long periods at or near the stall point is in very marked contrast to the performance under similar conditions with a hydrokinetic drive.

Crawler Tractors.—Either twin transmission units with separate drives to each track, or single units with conventional steering brakes in small crawlers can be employed. In the case of the twin transmission advantages in controllability are offered which cannot be obtained with any other transmission.

As is well known, the conventional crawler tractor is controlled by a series of clutches and brakes and, in steering, the first action is to disconnect the drive to one track. The second action, if necessary, is to brake that track, i.e., the inner track on the curve. With hydrostatic transmission, the ratio between the engine and each track can be varied completely independently. The drive to the inner track is not disconnected during the turn—the track is merely slowed down. Thus more accurate steering can be obtained and the drawbar pull can be maintained while turning.

Some designers in other fields of transmission have tried to achieve this objective either by the use of twin engines, with a separate engine driving each track, or by using electrical drives. The former arrangement has the disadvantage that small speed variations in the two engines can cause unwanted steering action. Systems using electrical drives are very heavy and are susceptible to ingress of water. Further, they cannot operate as efficiently as hydrostatic drives if they are being used to produce constant horsepower characteristics, as the normal characteristic in the electrical unit is constant torque.

Aircraft Towing Tugs.—The major feature is that smooth acceleration and braking limits the load applied to the aircraft attachment points. There is quite a high incidence of breakage of the nose wheels with towing, using conventional aircraft tugs, due to the snatch which occurs when the driver changes gear and, to an even greater degree, when the driver suddenly applies the brakes. With hydrostatic transmission, controlled rates of acceleration and deceleration can be applied, limiting the loads applied to the nose wheel to a magnitude which can be set and is known to be safe.

Shovels and Loaders.—The extreme manoeuvreability and ease of control, coupled with high efficiency, enables a greater amount of work to be carried out by a given size of machine and a give power. There is also another important feature. Loaders and shovels are very often driven into a bank of material which brings the vehicle to rest at the stall point. With a hydrokinetic convertor, almost all the power in the transmission is going into the stalled convertor, leaving no power available for the operation of the ancillary services and the raising of the bucket. In the case of the hydrostatic transmission, the amount of power going into the transmission at this stall point is very low indeed and the vast majority of the power is available for operation of the ancilliary services.

Off-the-road Transport.—Dumpers, forestry vehicles, and other types of vehicle on large pneumatic tyres can benefit from the characteristics of hydrostatic transmission in the same way as for other wheeled vehicles already mentioned.

Handling Equipment.—The main advantages for mobile cranes and fork-lift trucks are manoeuvreability and ability to inch the machine in and out of tight spots. In addition, a case can be made for the use of hydrostatic transmission in conjunction with electrical storage batteries. If the hydrostatic system is used, the electric motor with a series winding can be abandoned in favour of the constant speed shunt wound motor which gives a very much higher efficiency and can, overall, provide more horse-power-hours from the same storage battery.

Cranes, Excavators and Dragline.—In this field, the hydrostatic drive is competing mainly with clutches with fixed ratios or, alternatively, the use of Ward-Leonard equipment. The hydrostatic transmission, because it can operate at a constant horsepower, which neither the mechanical clutch or the Ward-Leonard designs are arranged to do, can increase the work which can be carried out by a given power and a given machine.

Marine Applications.—Cargo winches, handling equipment, steering gear, and stabilisers are already operated by hydrostatic units, but they are of much larger, heavier, and costly construction than the model now developed. The use of the new hydrostatic type of pump in such

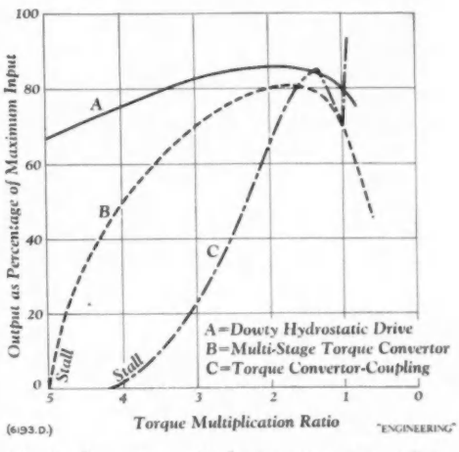


Fig. 4 Power transmitted at varying torque ratios.

applications will enable them to be very much reduced in size, especially if they are operated on a ring-main principle from a pressure-controlled pump.

An example of a hydrostatic-transmission application in another marine field, on which quite a lot of data has already been published, is in connection with tugs. There is a tug operating in the Port of London—the Tom Jay, fitted with a Hydropulsion unit which was

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AIR TRAVEL AT MACH 7

Basic Studies for a Hypersonic Aircraft

A hypothetical two-stage, " pickaback " aircraft capable of carrying 130 passengers nearly 9,000 miles at a speed of Mach 7 (over 5,200 m.p.h.) at heights between 130,000 and 145,000 ft has been described by Dr. R. R. Jamison, an assistant chief engineer of Bristol Siddeley Engines Limited and head of their ramjet department.

Dr. Jamison said that a preliminary project study had been attempted to get some of the " feel " for the problems in an aircraft of this nature, which might well provide a basis for a long-range transport capable of reaching any part of the world in one hop and at reasonable operating costs. Estimates of flight times over great circle routes from London showed that Vancouver could be reached in 75 minutes, Capetown and Tokyo in 90 minutes, and Singapore in 100 minutes.

Delivering a paper on hypersonic air-breathing engines to the Symposium on Hypersonic Flow organised by the Colston Research Society and the University of Bristol, Dr. Jamison said that, owing to military strategic requirements, there had been strong emphasis on studies of flight velocities of 9,000 knots (10,300 m.p.h.) upwards. Airborne flight with air-breathing propulsion had meantime progressed to speeds between 1,700 and 2,500 knots (1,950 to 2,900 m.p.h.), the higher speeds being with unmanned missiles, so that there was currently a gap which had received relatively little study.

Although the rocket vehicle had achieved precedence for military reasons, there was a continuing advance in aircraft capabilities and a continuing requirement, both civil and military, to deliver people and goods from point to point at ever higher speeds. For such missions, flight through the atmosphere appeared likely to be greatly preferred and to be more economic than rocket flight, and it was conceivable that orbital or even escape velocities might be generated in airborne flight with lower accelerations and probably substantially greater fuel economy. Emphasising that extensive research would be necessary, Dr. Jamison went on to discuss the technical aspects of designing and developing power-plants for hypersonic aircraft.

At about Mach 5, he said, a number of engineering problems were intensified in a way that suggested this was the threshold of a region in which progress would require considerable modification of design and development techniques, so that the hypersonic region was marked as a distinct field of aeronautical advance.

Boundaries set by acceptable limits for structure temperature and by aerodynamic limitations defined a region in which sustained flight should be technically possible, extending up to orbital speeds and even beyond. However, from present information it appeared that the upper limit of speed with chemical fuelling was about 7,000 knots (8,000 m.p.h.); above that speed, energy would have to be added by some form of electric or nuclear heating. It would therefore appear advisable to tackle the technical problems and gain experience in raising the speed of continuous airborne flight to such values before proceeding further.

It was in the speed range from 1,400 to 7,000 knots that the ramjet came into its own as the most effective air-breathing engine. Propulsion by a hydrocarbon-fuelled ramjet was therefore assumed, and it was notable that propulsion efficiency increased strikingly to a peak of about 67 per cent at Mach 7, and useful values persisted to still higher speeds. This suggested that Mach 7 was a good speed at which to aim as an initial target in projecting a hypersonic aircraft.

In the preliminary project study for such a machine, a long-range aircraft had been considered because the high efficiency of the power plant would be best deployed in this role. The transport envisaged would consist of two stages: an accelerating and launcher aircraft weighing about 240,000 lb carrying the " pickaback," and a hypersonic stage weighing about 160,000 lb. The launcher aircraft, which could be powered by a turboramjet combination engine, would take the hypersonic machine to about Mach 4 at 90,000 ft and then return to its parent airfield. Low wing loading and high take-off thrust would allow the parent machine to use short runways. The hypersonic aircraft would accelerate from launching speed and altitude to a cruise speed of about Mach 7 at 140,000 ft, gliding down at the end of the cruise to land at its destination. A light turbojet installation would be provided for landing approach.

Such a study, Dr. Jamison stressed, was of necessity somewhat speculative, but on present information the performance of the components appeared capable of attainment and the result pointed to an aircraft having capabilities striking enough to justify its serious consideration. A great deal more precision was required in its study, however, and that must depend on the acquisition of quantitative data in a wide range of topics in the hypersonic field of aircraft engineering. The problems in gas dynamics, chemical kinetics, structures and test equipment pointed to the need for a co-ordinated research programme which would enable them fully to survey the potentialities of hypersonic flight and to plan an engineering programme to achieve it.

Hydrostatic Drives *Concluded*

designed by Commercial Patents Limited—which has four 102 h.p. Gardner diesel engines, each having a pump which feeds through to a single hydraulic motor connected to the screws. In this case four inexpensive series-produced engines, for which very good servicing arrangements were available, were used in place of one large engine which would have cost considerably more than the four small engines. A much increased freedom of design was also obtained because the engines could be placed exactly where they were wanted. The engines can be removed very quickly for servicing and, moreover, the failure of any one engine does not put the tug out of action.

Industrial Drives.—There are many drives, in such applications as wire drawing, paper-making, and many others, which require variable-speed drive. The hydrostatic drive offers a cheaper alternative to the electrical variable speed drive with, in some cases, better performance.

Hydraulic Presses.—Due to the non-availability of reasonably priced variable displacement pumps, almost all British hydraulic presses use constant-delivery pumps. In Germany this is not so. There is little doubt that, given time, British designers of hydrostatic transmissions could build up a useful market for transmission-type pumps in presses.

FUTURE DEMANDS FOR AIRCRAFT ELECTRONICS

The arrangements already available for automatically landing an aircraft were referred to in some closing remarks of a lecture by Mr. E. H. Bruce-Clayton, the aeradio and planning superintendent of International Aeradio Limited, given to the Association of Supervising Electrical Engineers.

At the Blind Landing Experimental Unit, said Mr. Bruce-Clayton, equipment had now been in practical use for some time which is capable of automatically landing an aircraft. The aircraft was brought to within 300 ft of the ground by an instrument landing system which had been coupled to the auto-pilot. At this point, magnetic leader cables laid in the ground, and extending outwards for about a mile from the runway, took over the provision of azimuth guidance. At a height of 100 ft sensitive radio altimeters in the aircraft took over the elevation control from the glide path equipment, and generated signals in the airborne equipment to enable the flare-out to be completed and the throttles closed, thus effecting an automatic landing.

It might be a few years before the reliability of such equipment built up to the point which would permit its adoption by the airlines, but the possibility of being able to commence a flight, confident that a landing could be made at the intended destination, whatever the weather there, represented an economic and operational break-through of such importance that its development could not be long delayed.

Another topic of future interest discussed by the lecturer was the need for aircraft to be able to identify themselves to the ground radar by the transmission of coded signals from airborne equipment. Aircraft movements had been increasing in number for several years and the trend seemed to be to build aircraft which, though much faster, were not significantly larger. This pointed to a greater frequency of flights in order to gain economic utilisation of the aircraft, thus increasing the number of aircraft movements which had to be controlled safely and economically.

The use of radar in its present raw state would fail to meet the requirements of the future. Time was wasted finding out which particular aircraft was represented by an anonymous spot in the control screen, which was also cluttered up with a mass of unwanted responses from rain, storm clouds or high ground features.

If the aircraft could identify themselves the responses received by the ground radar would be extracted and separated from the extraneous clutter of unwanted signals. Then, together with the identification of the aircraft, this wanted data would be stored, and controllers would be able to extract it at will in order to resolve any particular traffic situation. From the data stored and the knowledge of the rate and direction of movment of each aircraft, it would be possible to artificially advance everything by several minutes, thus showing the situation that would exist if all aircraft continued to make the described movements.

Such developments in radar control would have their greatest application not at one particular airport but at the traffic control and communication centres serving a large area and possibly a number of airports.

It was also a fact that 80 per cent of all air to ground communications were standard routine messages and it was therefore possible to transmit them by automatic signalling methods. A number of standard messages, with facilities to amend the factors that did change (such as altitude, speed, track and so on) could be set up and transmitted automatically in an electronic code. At the ends of the link the message could be readily displayed in written form. This procedure would be a much more efficient use of the communications channel than was voice, and the message would then be in a form which could be stored and extracted at will, or transferred from one centre to another.

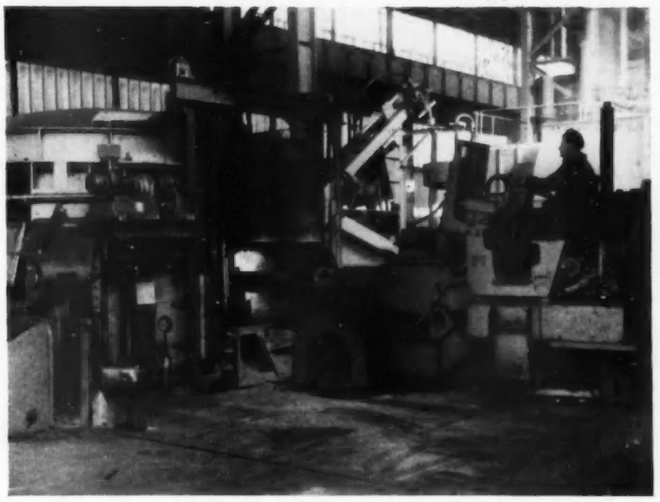
Much of Mr. Bruce-Clayton's remarks had been concerned with the electronic equipment which was at present normally employed on an airport for direct application to traffic movements. He had dealt with his subject under the headings of communications, air traffic control, navigation and landing aids, and meterology. Before concluding, however, he referred to some possible future trends as reported above.

FASTER STEEL PRODUCTION

Electric Furnaces Charged with Hot Metal

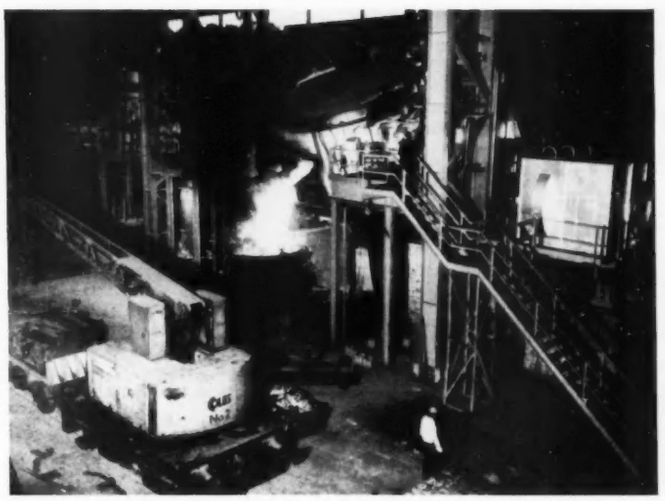
In recent years there have been numerous developments aimed at speeding up and cheapening steel production. The latest, just brought into use by Brymbo Steel Works Limited, Brymbo, near Wrexham, shares with some other processes one common factor—the use of oxygen for hot metal refining—but in other respects it breaks completely new ground, and is so far unique.

Brymbo works, on a site which has been connected with iron manufacture since the first quarter of the 18th century, has a long history of pioneer development work, and among other distinctions can claim the installation of the first basic open-hearth furnace in the British Isles in 1884. Open-hearth furnaces remained the sole means of steel production until 1939, when electric arc furnaces were installed; these were used in the normal way, with cold metal charges, while the open-hearth plant continued in operation using hot metal from the company's blast furnace, together with scrap; here again, the method of operation was orthodox. Experiments were undertaken in 1948 with the assistance of the British Iron and Steel Research Association on the de-siliconising of hot blast furnace metal by means of the oxygen lance, and by 1951 this process was in regular use. From 1937 onwards the output of the works had been concentrated on special low alloy steels and silico-manganese spring steel, and Brymbo developed into one of the largest producers in the country of the latter type of steel.



(Right) The Brymbo oxygen pre-refiner will deal with a percentage of cold scrap (seen being charged by a diesel mobile charger) as well as blast furnace metal.

(Left) For slagging off the pre-refiner tilts to the charging side; for tapping, in the opposite direction.



(Right) Tapping the charge of metal from the pre-refiner into a crane ladle.

Development

It was against this background that Brymbo considered after the war the replacement of the then existing open-hearth plant, which was rapidly becoming obsolete. It was decided to install new electric arc furnaces, and scrap the open-hearth plant, but a radical departure from normal practice was made in planning to continue the operation of the blast furnace and charge a proportion of hot metal to the electric furnaces.

The open-hearth furnace is well adapted to refine hot metal, the electric arc furnace, with its virtually sealed-off chamber, is not. As a result, it is more or less impossible to remove silicon, phosphorus and more than about 1 per cent of carbon in the electric furnace, except under conditions of very slow operation, high power consumption, heavy electrode wear, and heavy slag production. In some parts of the world the difficulty is overcome by duplexing—blowing the blast furnace metal in a Bessemer converter to remove all the metalloid impurities and then charging the blown metal to the arc furnace for deoxidising and finishing. This technique requires that the iron shall contain initially some 1·5 to 2 per cent phosphorus, and the Brymbo blast furnace metal runs only to about 0·6 to 0·8 per cent phosphorus, which is too much for the electric arc furnace to remove, but far too little to enable the basic converter to blow the metal to a workable temperature. There are other disadvantages inherent in the duplex process as well, and it was wholly unsuitable for use at Brymbo.

In its place a pre-refining process using oxygen has been installed. This process, first proved at Brymbo by extensive experiments on oxygen lancing in a ladle, has several advantages. It removes the silicon and phosphorus from the metal before decarburisation, and as a consequence the blown metal remains at a comparatively low temperature, making it easier to handle. Enough carbon is left in the metal to make final decarburisation in the arc furnace, using the oxygen lance, simple and rapid. Finally, the iron oxide content of the pre-refining slag can be kept quite low, making overall metal recovery high.

Pre-refining

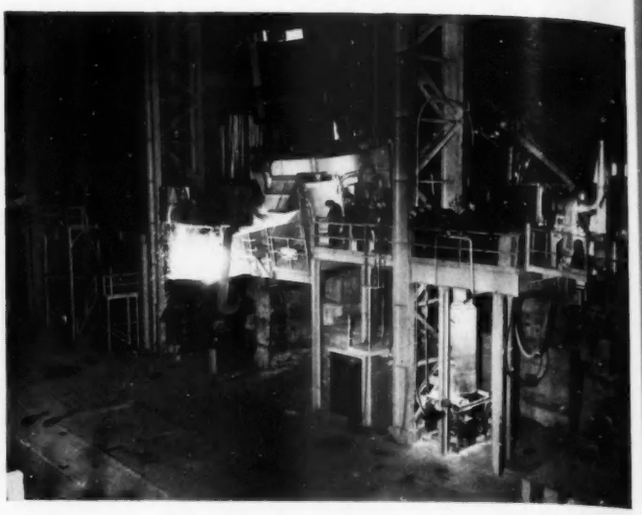
Designed by Brymbo technical staff in conjunction with the Wellman Smith Owen Engineering Corporation Limited, and built by the latter company, the pre-refining vessel is essentially a deep circular hearth 16 ft diameter, resting on rockers and rollers so that it can be tilted, and capable of taking 20 tons of molten metal. It has a basic (dolomite) lining and a high-alumina brick roof. The design of the vessel is covered by a number of patents.

Two special problems had to be met in designing the vessel, fume removal and control of the foaming and frothing of the slag during the reaction. For fume removal there is a wide water-cooled duct connected to a powerful fan and a chimney stack. At present the fumes are discharged to atmosphere from the stack, but a filtering plant is to be installed later. The duct remains in full operation when the vessel is tilted for slagging or tapping.

To control the foaming slag the hearth was deliberately made deep and in addition oil burners are mounted tangentially in the walls. An unusual feature is incorporated in the oil firing system. Air for combustion is passed

(Left) Charging pre-refined metal into the 40 ton arc furnace.

(Below) Arc furnace tapping. The inclined axial lance of the pre-refiner can be seen on the right, with the lime dispenser below.



under the furnace hearth to obtain a degree of pre-heat and at the same time to cool the hearth. The air supply can be enriched with oxygen tapped off the main supply.

Oxygen is injected through two water-cooled lances, one of which protrudes into the vessel at the axis of tilt, and so can operate when the vessel is tilted. The second lance is withdrawn before tilting; this lance is shortly to be replaced by one extending vertically through the roof. The lances can inject oxygen at up to 800 cu. ft per min. Oxygen can also be introduced by means of manually-operated lances pushed across the working door sill.

A particular feature of the Brymbo pre-refining vessel is the employment of fluidised powdered lime and limestone, fed into the metal with the oxygen stream to form the slag. A special dispenser made by the Yorkshire Engineering and Welding Company Limited, of Bradford, is used to introduce the powdered material into the lances.

Working a Heat

Blast-furnace metal at a temperature of 1,385° C is charged from a ladle carried by overhead crane, through a portable spout in the same way as on an open-hearth furnace, and the refining takes, at present, about 1 to 1½ hours. Details of a typical heat are:

Analysis of blast furnace metal:	C	.. ..	4·15 per cent
	Si	.. ..	0·47 ,,
	S	.. ..	0·048 ,,
	P	.. ..	0·63 ,,
	Mn	.. ..	0·85 ,,
Analysis of final metal:	C	.. ..	1·68 ,,
	Si	.. ..	Trace
	S	.. ..	0·04 ,,
	P	.. ..	0·036 ,,
	Mn	.. ..	0·14 ,,
Analysis of final slag:	CaO	.. ..	43·2 ,,
	SiO_2	.. ..	14·8 ,,
	P_2O_5	.. ..	9·1 ,,
	Fe	.. ..	6·9 ,,
Oxygen used per ton of meta.		.. ..	1,000 cu. ft
Percentage of scrap melted	..	.. ..	6·55 per cent
Overall efficiency of oxygen usage		.. ..	100 per cent
Overall yield of metal	.. ..	.. ..	93 per cent
Rise in temperature	.. ..	.. ..	150° C

It is expected that in the next few months this performance will show a considerable improvement. An additional advantage of the pre-refining vessel, not obvious at first sight, is that it will deal with quantities of large sized and awkwardly shaped scrap, which are undesirable in the electric furnace, where they tend to cause electrode breakage.

Arc Furnace Operation

As soon as the metal is pre-refined it is tapped into a ladle by tilting the vessel and taken to one of three Birlec 40 ton electric arc furnaces. These operate on a charge of 45 to 50 per cent hot metal and the remainder cold scrap, which is charged by crane bucket and brought to a state of incipient melting before the hot metal is added.

A normal operating cycle, with a tap-to-tap time of 4½ hours gives a productivity of about 10 tons/hr and it is expected that improvements will be achieved. In a typical heat 25 tons of cold scrap were charged, and power at 325V 20,000A was used for 1½ hr to melt the charge. Twenty tons of pre-refined iron were then charged, and after a short time oxygen was blown intermittently for 25 min by hand lance, suitable lime and limestone additions being made to the slag. A sample showed a carbon content of 0·56 per cent, and manganese was then added. On tapping, the product, silico-manganese steel, gave an analysis of C 0·55 per cent, Mn 0·82 per cent, Si 1·9 per cent, S 0·034 per cent and P 0·025 per cent.

For steel made in this way the power consumption averages 395 kWh/ton and the oxygen consumption in the electric furnace is 460 cu. ft/ton. Total oxygen (including that used in pre-refining) is 900 cu. ft/ton. For the same kind of steel made in cold metal 30 ton arc furnaces the usual heat time and power consumption are often double the present figures, and oxygen consumption averages 500 cu. ft/ton.

Plant and Buildings

The new oxygen-electric melting shop at Brymbo has been built on the site of an old slag tip, which, as it proved on investigation to be red-hot inside, had to be removed and replaced with some 180,000 cu. yd of blast furnace slag. The very difficult civil engineering problems set by the site conditions having been overcome, a building was erected to house the new melting and teeming plant, and the whole layout is such that scrap from the stockyards and hot metal from the blast furnace enter by short run, logical routing, and the cast ingots are removed by an equally simple route to the nearby rolling mill.

Two parallel bays, 432 ft long by 50 ft wide, form the new melting shop, the building being steel framed with a tubular monitor roof, the latter being of welded tubular construction. Welding has also been used in the main crane gantry girders, which are of all welded construction, and on the crane rails, which are welded at the joints. There are three cranes in each bay, all built by Sir William Arrol and Company Limited, and fitted with Metropolitan-Vickers motors. Two of the cranes in each bay are of 60 tons maximum capacity and one is of 25 tons; all have auxiliary hoists of lighter capacity for ladle tilting and general lifting.

In the melting bay there is a 150 ton metal mixer and in line with it the 20 ton oxygen pre-refining vessel and the three arc furnaces.

A tonnage oxygen plant, made by Air Products (Great Britain) Limited, to an American design, is installed at a short distance from the melting shop. It has a capacity of 24,000 cu. ft/hr.

Future Prospects

The Brymbo plant is new, but has already proved itself to be very satisfactory from the production and metallurgical points of view. As operating experience is gained, further advantages are expected, particularly in the matter of economics, and there is no reason why the process should not be extended to steel making processes other than those using arc furnaces. There is no technical reason, for example, why pre-refining on the Brymbo plan should not be used in conjunction with open-hearth furnaces, thus giving British operators some of the advantages which the Germans, for instance, enjoy with their low-phosphorus pig irons.

INCREASING POSTAL ORDER "OUTPUT"

A wish to lighten the weekly "football pools" postal order rush may well be the prime motive of the General Post Office in the development of automatic postal order dispensing machines. A unit of three prototypes has been installed in the Remnant Street (Kingsway) Branch Post Office, London, WC2, "to sell three of the most popular denominations of postal orders." The machines will sell 2*s*, 2*s* 6*d* and 5*s* postal orders on the insertion of a florin, a half-crown and two half-crowns respectively, each with a threepenny piece for poundage. A change-giving machine which issues two threepenny pieces for a sixpence has also been installed. Similar machines have been in use on the Continent for some time.

Operation and Maintenance

TRACING THE SOURCE OF A LEAK IN A FUEL TANK

Integral fuel tanks in the wings of P6M jet seaplanes, made by the Martin Company, Baltimore 3, Maryland, USA, are sealed internally and tested by filling them with compressed air, while a soapy solution is painted on the outside. A leak is shown by bubbling of the solution, but experience has shown that the source of the leak inside the tank may be many feet from the point at which it appears on the outside, the air passing through a minute cavity in the sealing compound. To trace the leak source is therefore often difficult and time consuming.

To solve this problem Martin have devised a system which uses gas injected from the outside, and detected at the leak source point inside by means of a probe which shows on a neon light when gas is present. The gas used is nitrous oxide, and it is injected from outside the wing into the leak escape point by means of a flexible hose with a rubber cup on the end. This confines the gas to the area at approximately 5 lb per sq. in, and the gas travels along the leak path to the source point inside the tank.

An operator inside the tank moves a probe in the suspected area until the infra red analyser to which it is connected detects the presence of gas and the neon light starts flashing, so indicating the source of the leak. Sensitivity adjustments on the unit provide for the detection of as little as 50 parts of nitrous oxide in one million parts of air.

Nitrous oxide gas injected from the outside of a Martin aircraft wing fuel tank is detected inside and so traces the source of a leak.

Nitrous oxide gas, being economical, inoffensive to human beings, non-corrosive and non-inflammable, is ideal for use in fuel tanks. The equipment is portable.

MULTI FACSIMILE COMMUNICATION

A new way has been devised of finding out how late your train is going to be, and of making sure that everyone who should know is informed simultaneously. A trial installation of the new system—known as the Deccafax Visual Communication System—is currently operating at King's Cross Station in London. The equipment is being used for passing train information from one central point to various sites in the station which relay such information to the travelling public.

The new system is intended to reduce telephone messages by providing visual written information to several positions simultaneously. Instead of being told on the telephone by the King's Cross signal-box staff, each official will receive the message simultaneously—the station announcer, the train arrival indicator board staff, the inquiry staff and the yard inspector. Transmission is by a photo-electric-cell system in conjunction with the flying-spot scanning technique. Messages for transmission are written either on a transparent surface over the face of the tube, or on a prepared transparent proforma. This is yet another system to reduce the human element in communications.

FLUCTUATING DEMAND FOR NATURAL GAS

The Economic Commission for Europe (ECE) is an indefatigable producer of reports, most of which are of great interest. This is certainly the case with a study of the problems of the gas industry which has been prepared by an ECE working party. The increased development of natural gas has produced an entirely new situation in what was a stable industry, making international cooperation much more important than ever before.

The major problem facing the industry is fluctuating demand. The answer is the development of underground storage, and the working party has attempted a systematic comparison of existing or projected forms of this. The question of relative costs of different methods, and the legal implications of underground storage were both put down for further study. Tariff policy was seen as the best method of evening out demand for gas but the difficulties of forecasting future needs make its operation somewhat uncertain. Another problem discussed was the possibility of standardising certain safety measures in connection with the legal protection of international pipe lines. The International Gas Union is being asked to prepare a set of model safety regulations based on the codes in use in the United States and Soviet Russia.

The working party was particularly interested in an account of the experiment of carrying of liquefied gas across the Atlantic by the Methane Pioneer (see ENGINEERING, 20 Feb., 1959, p. 232). The improvement of cost estimates for this means of transporting gas is being further studied by ECE with special reference to the competition that might develop between natural gas and other forms of energy. For the future the working party saw the development of natural gas as the subject on which it was most necessary to provide information, help and guidance to the European governments. Future work will be based on this assumption.

Marketing

Trade Mission to USSR

British exports of know-how and machinery to the Soviet Union may receive an added stimulus through the British trade mission which is now visiting Russia. Mr. Macmillan told the Commons on his return from Moscow that his suggestion for a trade mission was " warmly accepted by Soviet leaders." Sir David Eccles is leading the team, which left England on 12 May. Other members of the party are Sir Hugh Beaver, Mr. J. S. Gordon Clark, past-president of the Timber Trades Federation, Mr. L. W. Phillips, past-president of the National Federation of Corn Trades Associations, and Mr. J. B. Scott, chairman of the Russian section of the London Chamber of Commerce.

Business Efficiency Show

The considerable enterprise of the Office Appliance and Business Equipment Trades Association reflects the outstanding export commercial consciousness of the industry. Hitherto, the Business Efficiency Exhibition has been a biennial affair in London, with visits to the major cities in the provinces in the intermediate years. Pointing out that the industry's turnover has grown from £10 million to over £75 million in 12 years, and that competition in world markets has become very fierce, the Association announced that the Fair will be staged in London regularly " rivalling the great office equipment fairs of Paris and Zurich and the growing monster office equipment sections at the Hanover and Milan Fairs, designed to attract more overseas visitors to London than it has ever done before." The provincial exhibitions will not be cut out, but increased.

This year's BEE opens at Olympia, London, on 25 May and will run until 4 June. Great efforts have been made to attract overseas buyers (they came from 67 countries in 1957) and there will doubtless be considerable interest since the industry currently exports £27½ million worth of office equipment, almost a tenth of this to the United States and Canada. The United States is now the industry's second best export market and is rapidly gaining on Australia. American imports from Britain in March amounted to nearly £180,000, compared with £92,000 in March last year. Although the industry's world shipments were down by £200,000 to £4·7 million in the first quarter of the year, exports to the four major markets—Australia, South Africa, the United States and France—all increased satisfactorily. The biggest drop was in exports to Canada, which were down by £105,000.

Tough to Tender

Greater expenditure of " time and brain power to exploit our tradition as a capital exporting country," was advocated by Sir Kenneth Hague, deputy chairman of Babcock and Wilcox, in a speech to the Advertising Association's annual conference. He spoke of the problems makers of capital goods had to face. One of these was the very high cost of tendering: tenders costing a total of half a million pounds would frequently be offered for one project costing eight million pounds. Firms cannot afford to make many such tenders without getting an order. Another major problem was the long execution cycle of a capital project. From seven to ten years might elapse between the conception of a project and its completion, and this meant that long term trends, economic and political, had to be taken into account.

In this country and in many overseas markets it is becoming easier to calculate the future demand for plant and machinery. Nationalisation has reduced the number of buyers, and state

projects are becoming the rule where major investment is concerned. It is therefore more practicable to keep in touch with customers and potential customers. Air travel now makes it possible to get almost anywhere quickly and in comfort. Sir Kenneth advocated that executives and engineers should keep in touch by personal visits with buyers of capital goods all over the world. Only in this way can Britain maintain her position against growing foreign competition.

Dowty at Cleveland

Successful entry into the North American market with British made equipment can be a time and money consuming exercise, but when it comes the rewards are high. In a field of engineering as highly developed as mining equipment one could expect the entry to be more difficult and the rewards substantially higher than normal. Dowty Mining Equipment are therefore playing for high stakes when they exhibit their " Roofmaster " system of self-advancing hydraulic roof support at the Cleveland, Ohio, coal show on 11 to 14 May.

The " Roofmaster's " appeal to American mine managers lies in the manpower savings it makes possible. On longwall faces in this country it has cut labour costs considerably, since only two men are required for the continuous operation of 200 support frames. In the United States coal is largely won by shortwall methods but Dowty's believe that their " Roofmaster " system could make longwall mining highly competitive and bring major changes in American practice. They have, however, developed a system suitable for shortwall methods. This is an automatic hydraulic roof support based on the " Roofmaster " principle. Dowty's are the only British company exhibiting at Cleveland.

Signs in the Country

A drive to end the " clutter " of advertisements on shops and elsewhere is imminent. Mr. Henry Brooke, Minister of Housing and Local Government, told the Electric Sign Manufacturers' Association that the Government are determined to rid the country of such eyesores but that he hoped there would be a " voluntary control " by the industry. The Outdoor Advertising Industry Advisory Committee were engaged in drawing up a code which Mr. Brooke hoped would be effective to deal with this problem: " I would far rather clutter was stopped and removed by voluntary action. I believe we could achieve success faster that way, if everyone seriously tried. I want no one to be in any doubt that by one method or another I intend to get rid of clutter, for I am sure it does no good to anyone "

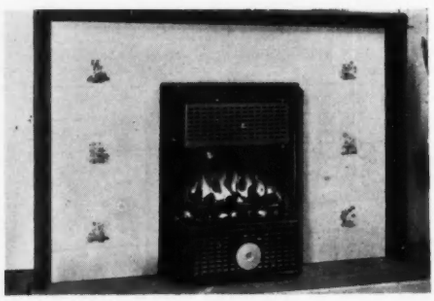
Mr. Brooke told members of the Association that he was considering making two changes in the advertisement regulations. The first was to lessen the inflexibility of the present regulations relating to areas of special control and the second change was " to simplify and lubricate the machinery of advertisement control." They are expected to lead to more flexible and more effective controls and to give the manufacturers of electrical signs a better opportunity of making their contribution, in good taste, to the ordinary citizen's enjoyment of his town or village.

At Home

EFFICIENT OPEN FIRES

At the same time as the announcement of the Coal Board's summer prices comes the news that in future coal may be supplied in different colours to distinguish the various grades—gold, presumably for the best, silver and red (for danger?). It will be delivered in paper bags of 16 or 24 lb by white coated salesmen or it may be obtained from slot machines. A side note says that the spraying will help to bind the dust.

The Sofono Super-View has an adjustable throat restrictor and a spin wheel for fine control.



This year the summer prices, which came into force on 1 May, will be 10*s* a ton below the basic price throughout the country, thereby abolishing the differential that existed last year between south and north. From 25 October prices will be 10*s* above the basic. Be it noted that these are the changes in prices to the trade: retail prices are no longer subjected to control and the householder merely hopes the reductions will be passed on. The Board also speak of an incentive scheme to encourage householders to stock NCB coke during the summer.

There is a height adjustment of 5 in on the Rayburn, which also has an adjustable restriction.

It is interesting to note that in spite of the considerable competition from oil, gas and electricity the NCB sold more house coal during the past winter than in the one before—which may indicate that more is actually being burnt or merely that less was purchased during the summer. Still it does show that the coal fire retains its popularity.

Although it is claimed to be the cheapest fuel for space and water heating, there is no doubt that the house holder wants value for money. Therefore it is up to him to install the most efficient burning appliance he can. To assist in the matter, the Coal Utilisation Council, whose head office is at 3 Upper Belgrave Street, London, SW1, has issued lists of approved distributors of domestic solid fuel appliances, divided into regions. The CUC point out that at least one member of the staff of the firms named has taken a course at the Council's training centre, and is therefore qualified to give impartial advice. A new list (No. 16) of approved solid fuel appliances was issued this month.

One of the complaints against the open fire is that a lot of heat is wasted up the chimney, and to the surrounding walls. This can be overcome to a large extent by the convector fire which has a passage at the back so that air from the room can pass freely behind it and is heated in its passage before returning to the room above the fire. An alternative arrangement allows the heated air to be piped to the room above. Examples of these " free standing " fires, which fit snugly into the usual type of surround, are illustrated on this page. There are many others.

Smoke is said to be drawn downwards in the Parkray and consumed. More louvres can be added.

All types have one claim in common: they can be installed by the average handyman in an existing grate. They differ somewhat in structure in that some have the back plate (which forms the rear wall of the convector section) as a separate item fixed to the back of the fireplace, while in others it is integral with the main body. In a third version the original back of the fireplace itself forms the back plate. There are differences too in the way in which the outlet is fitted to the flue.

The flow of gases up the chimney is restricted by a throat, which in most cases incorporates some degree of adjustment either semi-permanent to suit the installation or variable to suit the burning conditions required. The flow of primary air is also controllable, in some cases by a spin wheel for very accurate adjustment. The convection flow, however, is uncontrolled.

Apart from the free-standing models considered above, which are virtually self-contained units, there are other convector open fires which need rather more structural work for installation and indeed may be best fitted when the house is being built. With these it is also possible to fit a back boiler to give a hot water supply.

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